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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

MARINE AIR-GROUND TASK FORCE DISTRIBUTION IN THE BATTLESPACE

by

Sarah E. Bergstrom
Margaret K. Snyder

September 2016

Co-Advisor:
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**MARINE AIR-GROUND TASK FORCE DISTRIBUTION IN THE
BATTLESPACE**

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ABSTRACT

This thesis applies a systems thinking methodology to produce a proof of principle decision support dashboard that integrates relevant Marine air-ground task force (MAGTF) logistics systems to assist the tactical level commander to better manage ground and air transportation assets. For this thesis, the researchers define the MAGTF system in terms of three components: 1) organization design, 2) IT systems, and 3) feedback control. The researchers looked at the existing Log IT systems supporting the current MAGTF organization and assessed how well our application design can use and access existing logistics databases to improve logistics decision-making. The researchers discovered that effective application design depends on selecting the appropriate organizational level of war the application is designed to support: 1) strategic, 2) operational and 3) tactical. By developing a proof of principle application that accesses existing databases and applying a systems thinking methodology, the researchers demonstrate how information can be used to enhance the MAGTF commander's decision making for more efficient and effective employment of transportation assets in the battlespace. The potential benefit of this research is a proposed systemic structure with an associated web application that provides the MAGTF commander with critical information for supporting operations.

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TABLE OF CONTENTS

I. INTRODUCTION	1
A. EXPEDITIONARY FORCE 21.....	1
B. LOGISTICS INFORMATION TECHNOLOGY AS A CAPABILITY	2
C. BACKGROUND ON SYSTEMS THINKING.....	3
D. IMPLEMENTING LOGISTICS MODERNIZATION	3
E. PROBLEM STATEMENT	4
F. PURPOSE STATEMENT.....	5
G. SCOPE AND METHODOLOGY	5
1. Scope.....	5
2. Methodology	6
3. Primary Research Questions	6
4. Benefits of Study	6
5. Organization of Thesis.....	7
II. LITERATURE REVIEW AND OVERVIEW OF CURRENT SYSTEM.....	9
A. LOGISTICS MODERNIZATION POLICY	9
1. MARADMIN 444/05.....	9
2. MCBUL 4081: MAGTF Logistics Support Systems (MLS2)	10
3. MCO 4000.51: Automatic Identification Technology (AIT).....	12
4. MCO 4470.1A: USMC MAGTF Deployment and Distribution Policy (MDDP).....	13
5. Theater Battle Management Core System (TBMCS).....	13
6. Logistics Information Technology (Log IT) Portfolio Strategy	14
B. CHALLENGES OF IMPLEMENTATION.....	15
1. Lack of Standard Procedures	15
2. Lack of Formal Reports	15
3. Lack of Integration	16
C. GAP ANALYSIS AND WAY FORWARD	17
1. Gap Analysis.....	17
2. The Way Forward.....	17
III. APPLIED SYSTEMIC APPROACH TO THE MAGTF.....	19
A. ORGANIZATION DESIGN	19

1.	Organization Design Related to Efficiency	20
2.	Strategic Level	21
3.	Operational Level.....	21
4.	Tactical Level	22
B.	APPLYING ORGANIZATIONAL DESIGN TO LEVELS OF WAR.....	22
1.	Mechanistic Design	22
2.	Organic Design	24
C.	IT SYSTEMS APPLIED TO ORGANIZATIONAL DESIGN	26
D.	IT SYSTEMS FOR TRANSPORTATION	27
1.	GCSS-MC	28
2.	MLS2 Systems	28
3.	TBMCS	29
4.	Importance of Metrics	30
E.	FEEDBACK CONTROL MODEL	30
F.	PROPOSED SYSTEMIC STRUCTURE	32
IV.	DEVELOPMENT TOOLS AND APPLICATION METHODOLOGY	35
A.	ORACLE BACKGROUND	35
B.	ORACLE FUSION	36
1.	Oracle Fusion Applications.....	37
2.	Oracle Fusion Middleware.....	37
3.	Oracle Fusion Architecture.....	38
C.	SQL DEVELOPER.....	38
D.	JDEVELOPER.....	39
E.	ADF	40
1.	The Business Layer	42
2.	The Model Layer.....	43
3.	The Controller Layer.....	44
4.	The View Layer	44
F.	WEBLOGIC SERVER.....	45
G.	SUMMARY	47
V.	USE CASE AND APPLICATION OUTLINE	49
A.	INTRODUCTION.....	49
B.	USE CASE	50
C.	APPLICATION DEVELOPMENT PROCESS.....	51
1.	Products Utilized	51
2.	Database Extraction/Insertion.....	51
3.	Reviewing Schemas and Data	52

4.	Designing the Application	53
D.	PAGE DESIGNS/FUNCTIONALITIES	54
1.	Home Page	54
2.	Air Page.....	54
3.	Ground Page.....	56
4.	Combo Page.....	58
E.	FUTURE ITERATIONS	60
VI.	CONCLUSION.....	63
A.	SUMMARY	63
B.	RESEARCH QUESTIONS	65
C.	LESSONS LEARNED AND RECOMMENDATIONS	66
D.	FUTURE AREAS OF RESEARCH.....	69
	APPENDIX A. DEPLOYED MDDOC STRUCTURE TEMPLATE	71
	APPENDIX B.	73
A.	TCPT DATABASE	73
1.	TCPT Schema.....	73
B.	TBMCS DATABASE	75
1.	ATOPLN Schema.....	75
2.	FROBDB Schema.....	76
3.	TMBSUP Schema.....	77
	APPENDIX C.....	79
A.	AIR PAGE	79
1.	View Objects:	79
2.	View Links	83
3.	Application Module	84
B.	GROUND PAGE.....	84
1.	View Objects.....	84
2.	View Links	89
3.	Application Module	89
C.	COMBO PAGE.....	90
1.	View Objects.....	90
2.	View Links	94
3.	Application Module	95
	APPENDIX D.....	97
A.	GENERAL STEPS.....	97

1.	Create A New Application in JDeveloper.....	97
2.	Create a Connection in JDeveloper to the Database with the Tables Listed in Appendix B.	97
B.	BUILDING THE MODEL PROJECT	98
1.	Create Entity Objects for Tables Listed in Appendix B.	98
2.	Create View Objects as Identified in Appendix C.	99
3.	Create View Links between the View Objects	100
4.	Create All Required Transient Attributes in the View Objects	101
5.	Create an Application Module for Each of the Different Pages (Air, Ground, and Combo) in Order to Test the View Objects' Functionality.....	102
C.	BUILDING THE VIEW CONTROLLER PROJECT.....	102
1.	Task Flow.....	102
2.	Home Page	104
3.	Air Page.....	106
D.	GROUND PAGE.....	112
E.	COMBO PAGE.....	118
F.	COMBO TOTALS.....	123
G.	DEPLOYING TO WEBLOGIC SERVER FOR TESTING	128
	LIST OF REFERENCES.....	129
	INITIAL DISTRIBUTION LIST	133

LIST OF FIGURES

Figure 1.	USMC Logistics Systems Architecture. Source: R. Barber, personal communication, June 30, 2014.	11
Figure 2.	Organic and Mechanistic Design. Source: Daft (2013), p. 31.	19
Figure 3.	The Relationship of Organization Design to Efficiency versus Learning Outcomes. Source: Daft (2013), p. 98.	20
Figure 4.	A Simplified Feedback Control Model. Source: Daft (2013), p. 314.	30
Figure 5.	Proposed Systemic Structure. Source: Capt Sarah Bergstrom, 2015.	32
Figure 6.	Overview of the Fusion Middleware Solution. Source: Oracle (2010).	38
Figure 7.	SQL Developer Main Window. Source: Oracle (2013).	39
Figure 8.	JDeveloper's Integrated Development Environment. Adapted from: Ronald (2011).	40
Figure 9.	ADF Framework Architecture. Source: Gordon et al (2011).	41
Figure 10.	ADF Business Components. Source: Gordon et al (2011).	43
Figure 11.	Task Flow. Source: Gordon et al (2011).	44
Figure 12.	Oracle ADF Architecture. Source: Ronald (2011).	45
Figure 13.	WebLogic Server. Source: Oracle (2016a).	46
Figure 14.	MEB Scenario. Adapted from: Marine Corps Sponsors and Capt Snyder (2016).	50
Figure 15.	ER Diagram for TCPT	52
Figure 16.	ER Diagram for TBMCS	52
Figure 17.	Transportation Capacity Tool Application Task Flow.	53
Figure 18.	Transportation Capacity Tool Application Home Page.	54
Figure 19.	Transportation Capacity Tool Application Air Page.	55
Figure 20.	Transportation Capacity Tool Application Ground Page.	56

Figure 21.	Transportation Capacity Tool Application Ground Page	58
Figure 22.	Transportation Capacity Tool Application Combo Page.....	59
Figure 23.	Transportation Capacity Tool Application Combo Totals Page.....	60

LIST OF ACRONYMS AND ABBREVIATIONS

2D	two-dimensional
AAR	after action report
ABP	air battle plan
ACE	air combat element
ADF	application development framework
AIS	automatic information systems
AIT	automatic identification technology
ALU	Army Logistics University
API	application program interface
ASR	assault support request
ATO	air tasking order
BCS3	Battle Command Sustainment Support System
C2	command and control
CE	command element
CLB	combat logistics battalion
CLC2S	Common Logistics Command and Control System
CMB	contact memory buttons
DC, I&L	Deputy Commandant, Installations and Logistics
DLC	distribution liaison cell
DS	direct support
EF21	Expeditionary Force 21
ELS2	enterprise logistics support systems
ER	entity relationship
GCE	ground combat element
GCSS-MC	Global Combat Support System-Marine Corps
HQMC, I&L	Headquarters Marine Corps, Installations and Logistics
ICC	integrated circuit chips
IDE	integrated development environment
ISO	International Organization for Standardization
IT	information technology

ITV	in-transit visibility
Java EE	Java platform, enterprise edition
LZ	landing zone
LCE	logistics command element
Lt Gen	Lieutenant General
Log IT	logistics information technology
Log OA	logistics operational architecture
LOGMOD	logistics modernization
MAGTF	Marine air-ground task force
MARADMIN	Marine administrative message
MAW	Marine air wing
MCB	Marine Corps base
MCBUL	Marine Corps bulletin
MCCSSS	Marine Corps Combat Service Support School
MCDP	Marine Corps doctrinal publication
MCO	Marine Corps order
MDDOC	MAGTF deployment and distribution operations center
MDDP	MAGTF deployment and distribution policy
MEB	Marine expeditionary brigade
MEF	Marine expeditionary force
MEU	Marine expeditionary unit
MLS2	MAGTF logistics support systems
MOS	military occupational specialty
MSC	major subordinate command
OIF	Operation IRAQI FREEDOM
OMC	optical memory cards
OAG	operational advisory group
PoP	proof of principle
PRB	purchase request builder
QUADCON	quadruple container
R2P2	rapid response planning process
RAD	rapid application development

RCT	regimental combat team
RDBMS	relational database management system
RFID	radio frequency identification
SIXCON	six container
SOA	service-oriented architecture
SOP	standard operating procedures
SQL	structured query language
TACC	tactical air command center
TBMCS	Theater Battle Management Core System
TCPT	Transportation Capacity Planning Tool
USMC	United States Marine Corps
WgPM	wing procedure manual

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I. INTRODUCTION

This chapter is an introduction to Marine Corps logistics modernization efforts and systems thinking methodology. Section A is an overview of the logistics goals outlined in Expeditionary Force 21 (EF21). Section B defines logistics information technology (Log IT) Systems as a capability to enable Marine logisticians to meet the logistics goals of EF21. Section C provides background on systems thinking methodology and Section D discusses how to use systems thinking methodology for successfully implementing logistics modernization. The remainder of the chapter provides the reader with the problem and purpose statement along with a scope in order to answer the research questions and organize the thesis to comprehensively address this topic.

A. EXPEDITIONARY FORCE 21

Expeditionary Force 21 (EF21) is the Marine Corps' capstone concept outlining the vision for designing and developing a modernized force that will be able to overcome challenges Marines will face in a future environment expected to be both complex and dynamic (HQMC, 2014a, p. 2). EF21 emphasizes that, in the future, Marine logisticians need to be guided by two goals: 1) support an expeditionary mindset and 2) maximize organic capabilities and limit contracting (HQMC, 2014a, p. 41). Marine logisticians can achieve these two goals by changing how they support the warfighter and by using logistics information technology (Log IT) systems more effectively.

EF21 emphasizes a light force primarily using a responsive method of support vice an anticipatory method in order to reduce stockpiling land-based resources and reduce burdening the supported unit with excess supplies. A responsive method of support optimizes the resources on hand, and limits the transportation needed to keep units supplied. To be responsive, and to support an expeditionary mindset, Marine Corps logisticians must share information across units while reducing uncertainty in a fluid and complex environment. This requires Marine logisticians having accurate near real-time information to successfully accomplish the rapid response planning processes (R2P2) for

operations. By using Logistics IT systems more effectively when planning and supporting operations, Marine logisticians will better support the warfighter and meet the demands of an expeditionary mindset while maximizing organic capabilities. Log IT systems are an enabling technology and provide Marine logisticians increased capability to meet the goals of logistics modernization as outlined in EF21.

B. LOGISTICS INFORMATION TECHNOLOGY AS A CAPABILITY

Richard Daft states in his book *Organization Theory and Design* that information technology (IT) provides many benefits to the organization and has been a crucial factor in helping organizations maintain their competitive edge in an increasing global environment (Daft, 2013, p. 309). When used appropriately, IT can improve decision-making, and enhance control, efficiency and coordination of the organization both internally and externally (Daft, 2013, p. 309). Marine logisticians can improve their planning by using Logistic IT systems to provide metrics on how transportation assets are being used at the tactical level.

Log IT systems are an enabling capability because a Marine logistician can use these tools to provide analytics that will enhance the MAGTF commander's decision and actions. For example, transportation metrics aggregated at the MAGTF command element (CE) provides the commander data on how his or her transportation assets are being used across the organization. If one element of the MAGTF is more efficient compared to the other elements than the MAGTF commander can implement these better processes across the MAGTF and increase the effectiveness of his organization as a whole. Furthermore, these analytics can be used to change how Marine logisticians support the warfighter, which helps the Marine Corps to maintain their competitive edge in a complex, dynamic environment as described in Expeditionary Force 21 (EF21).

Therefore, modernizing Marine logistics with respect to Log IT systems as an enabling capability is a necessary step in meeting the vision of EF21; but, unfortunately, logistics modernization has been a long, unsynchronized process leading to slow, sometimes unsuccessful change. Understanding the challenges of an unsynchronized

approach to logistics modernization, this research implements a systems thinking methodology to capture the process and identify the levers needed for change.

C. BACKGROUND ON SYSTEMS THINKING

Logistics modernization was meant to change how Marine logisticians use Log IT systems in support of their daily tasks. Unfortunately, implementing change within an organization is difficult, especially an organization notorious for resistance to change such as the military. Change is even more difficult to implement within organizations that operate in fluid and complex environments like those described in EF21. In order to reduce this complexity, this research applies a systems thinking approach to overcome the challenges of modernization and meet the two logistics goals of Expeditionary Force 21 (EF21): 1) support an expeditionary mindset and 2) maximize organic capabilities and limit contracting (HQMC, 2014a, p. 41).

Systems thinking is a discipline used to capture all of the components within the whole framework of an organization. When applied, the systems design shows the interrelationships of these different components revealing the structures that underlie complex situations, and displaying which factors can be leveraged for high or low change (Senge, 1990, pp. 68–69). Within systems design, there are multiple structures that can be applied to determine the degree of interrelationships and analyze the importance of each factor. For this thesis, the researchers define the MAGTF system in terms of three components: 1) organization design, 2) IT systems and 3) feedback control. By analyzing the interrelationships of these components and determining the importance of each, the researchers discovered current gaps in the MAGTF system.

D. IMPLEMENTING LOGISTICS MODERNIZATION

During 28–31 July 2015, the researchers, Captains Sarah Bergstrom and Margaret Snyder, observed internal organizational processes and interviewed process owners at I MEF located at Marine Corps base (MCB) Pendleton, California in order to study how effectively I MEF was able to implement LOGMOD initiatives published by HQMC, I&L. By observing several process owners at the operational and tactical levels, the researchers found that each major subordinate command (MSC) within I MEF used Log

IT systems based on the information requirements dictated by their commanders. Moreover, these Log IT systems were used in a different capacity depending on whether or not the unit was in a garrison or tactical environment. The researchers found that implementing policy and guidance within the organization was challenging given the excessive number of Log IT systems available to Marine logisticians and the amount of direction provided by Headquarters Marine Corps, Installations and Logistics (HQMC, I&L). Overall, this unsynchronized process led to slow change within the organization.

Therefore, in order to appropriately address the problem of how logistics modernization is successfully implemented throughout the Marine Corps, the researchers studied the information gaps within the current MAGTF system by defining it in terms of organization design, IT systems and feedback control at each level of war. By addressing the levers of change within the organization, Marine logisticians will better support the warfighter and meet the EF21 logistics goals across the organization in a synergistic manner. With a well-defined process, the MAGTF commander will have increased situational awareness and be enabled to make decisions based on accurate, near real time information provided by Log IT systems. The MAGTF commander will also be able to provide accurate reports to the operational and strategic levels and receive better support from supporting agencies based on updated information on logistics capabilities. This thesis focuses on transportation assets within the MAGTF to demonstrate how Marine logisticians can use Log IT systems more effectively with feedback control at the MAGTF commander level.

E. PROBLEM STATEMENT

The MAGTF lacks decision support tools for transportation asset employment and supply tracking visibility from subordinate units. This lack of visibility into transportation assets prevents tactical level commanders from making timely and informed decisions required to effectively plan for operations. Marine logisticians working with multiple Log IT systems experience reduced efficiency, wasted time, higher costs and increased risk of not supporting operations in an expeditionary manner.

F. PURPOSE STATEMENT

The study developed a proof of principle decision support dashboard that integrates relevant MAGTF logistics systems to aid the tactical level commander's decision-making process during sustainment operations. The researchers also investigated the feasibility of using rapid application development (RAD) tool to create web analytics in order to support the decision making process. The potential benefit of this research is a methodology with associated application that provides the MAGTF the critical information required to make efficient decisions on the utilization of transportation assets.

G. SCOPE AND METHODOLOGY

This section includes the scope and methodology. After applying a methodology, the researchers present the primary research questions that frame the research. In answering these research questions, the authors provide the benefits of this study. Finally, the researchers provide the organization of the thesis to give the reader an outline of what the study will accomplish.

1. Scope

This study concentrates on the Marine expeditionary unit (MEU) because the MEU combines all the elements of the MAGTF in a tactical setting. Furthermore, the appropriate subject is the MAGTF CE S-4 at the MEU because this organization has an internal focus of supporting transportation at the tactical level and is responsible for tracking transportation metrics for the MAGTF. This thesis reviews Log IT systems used at the tactical level of the MAGTF in order to observe how effectively LOGMOD initiatives have been implemented by the organization. Based on this analysis, the researchers designed and developed a decision support dashboard that will be used by the MAGTF CE S-4 to aid in decision making at the tactical level for transportation.

The dashboard will be centered on a use case provided by the sponsors that will allow MAGTF commanders to more effectively employ their air and ground transportation assets during sustainment operations. The researchers accomplished this by

pulling data from Transportation Capacity Planning Tool (TCPT) and Theater Battle Management Core System (TBMCS) to test metrics of performance and assess transportation usage. By using metrics of performance, the MAGTF commander will gain a better understanding of how well the organization is performing its tasks based on feedback provided by Log IT systems and interpreted by Marine logisticians.

2. Methodology

The methodology for this thesis includes the following steps:

- Conduct a literature review and evaluation of organizational design and logistic IT systems
- Complete a requirements/gap analysis of current Marines Corps policy
- Determine organizational design and apply appropriate IT system
- Define metrics of performance for analyzing transportation use cases
- Develop a conceptual dashboard
- Assess the dashboard

3. Primary Research Questions

What is the current organization of the MAGTF as it relates to Log IT systems to include for example, roles, users, and functionality? How well can the developed application design use and access existing logistics databases? Through analytics, how can we use information from command and control (C2) and in-transit visibility (ITV) databases to effectively employ air and ground distribution of supplies to support the MAGTF?

4. Benefits of Study

The proposed proof of principle product provides the MAGTF commander with a dashboard to analyze the use of both air and ground transportation assets at the tactical level. By having this information readily available, a commander can make decisions on how to better employ these assets to ensure equipment and supplies are being transported in the most effective and timely manner. Another potential benefit of integrating aviation and ground logistics systems is reducing the delivery time for equipment and supplies by

more efficiently using available lift capability within the MAGTF. Furthermore, the application combines relevant information from multiple systems into one database, which eliminates redundancies in systems and stream-line decisions in regards to logistics and supply management.

5. Organization of Thesis

This thesis approached logistics modernization from a systems thinking perspective in order to achieve the logistics principles set forth in EF21. The researchers have divided this work in two phases. Phase one encompasses Chapters II and III. First, the researchers reviewed current logistics modernization policies published by the Marine Corps and identified gaps within the current structure for implementing these policies. Chapter III defined and applied a systems design to the Marine air-ground task force (MAGTF) in order to identify the levers needed for change within the system and provided a proposed systemic structure for analyzing future iterations of logistic modernization efforts.

Phase two involves Chapters IV and V. These chapters demonstrate why it is essential to apply systems design when using IT systems by creating a proof of principle transportation dashboard. This dashboard shows how the Marine Corps can successfully implement change by applying the appropriate organizational design and feedback mechanisms to Log IT systems in order to increase situational awareness at the tactical level and provide the information necessary for the MAGTF commander to make a decision. Chapter IV encompasses the development tools and methodology associated with building the proof of principle application. Chapter V describes the use case and the researchers demonstrate how the proof of principle application could be used to provide both air and ground transportation metrics to the MAGTF commander. Last, Chapter VI is a summary of the research, including lessons learned and recommendations for future research on this topic.

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II. LITERATURE REVIEW AND OVERVIEW OF CURRENT SYSTEM

This chapter is a review of the current policies, orders and strategy documents that are used by Marine logisticians for logistics modernization. This research is valuable because analyzing the current logistics modernization efforts will allow the researchers to identify gaps with the current process. By identifying the gaps, the researchers chose an appropriate methodology to improve how the Marine Corps implements Log IT systems, which is discussed in Chapter III. Section A covers current logistics policy. Section B discusses challenges of implementation and integration of both air and ground systems. Section C provides a gap analysis and recommended way forward based on the literature review of the current system.

A. LOGISTICS MODERNIZATION POLICY

In 2005, the Marine Corps developed and published its vision for logistics modernization (LOGMOD) via MARADMIN 444/05 based on lessons learned from Operation IRAQI FREEDOM (OIF) (HQMC, 2005). This vision aimed at several initiatives including upgrading the supply and maintenance systems, improving information shortfalls, providing a total asset and in-transit visibility (ITV) capability, and streamlining a distribution system in order to improve logistics effectiveness within the Marine air-ground task force (MAGTF). Since 2005, several more policies and Marine Corps orders (MCO) have been written and published in the spirit of LOGMOD. These policies include Marine administrative message (MARADMIN) 444/05, Marine Corps bulletin (MCBUL) 4081: MAGTF Logistics Support Systems (MLS2), MCO 4000.51: Automatic Identification Technology (AIT), MCO 4470.1A: United States Marine Corps (USMC) MAGTF Deployment and Distribution Policy (MDDP), and Logistics IT Portfolio Strategy.

1. MARADMIN 444/05

LOGMOD concluded that legacy systems and stove-piped information reduces logistics effectiveness. MARADMIN 444/05 classified Global Combat Support System-

Marine Corps (GCSS-MC) as a critical Log IT system that will overcome these information gaps. GCSS-MC is an enterprise solution that has updated and integrated multiple IT systems to improve Marine Corps capabilities. Using a phased approach, GCSS-MC successfully replaced multiple legacy systems and integrated functions of logistics, such as supply and maintenance to facilitate greater synergy at the tactical and operational level. Initially, the Marine Corps expected GCSS-MC to be operationally capable within seven years of implementation. However, GCSS-MC has not reached full maturity as of 2015. As a result, supply and maintenance transactions are fully supported by GCSS-MC, but there is no dashboard that provides analytics on these transactions. GCSS-MC also lacks the ability to integrate both Marine air and ground transportation assets in order to fully optimize lift capability and availability. In order to overcome this capability gap, MARADMIN 444/05 designated several Log IT systems as program of records until GCSS-MC is fully capable.

MARADMIN 444/05 formally identified several systems within the USMC Logistics Information Systems portfolio/program of records to support increased visibility across the battlefield. These systems include: Battle Command Sustainment Support System (BCS3), Transportation Capacity Planning Tool (TCPT) and Common Logistics Command and Control System (CLC2S) (HQMC, 2005). While it is recognized that using multiple systems are not ideal, it is necessary that Marine logisticians use them in the interim while GCSS-MC is still being developed. This policy was promulgated in 2005 and is still active until GCSS-MC is capable of providing the needed information for Marine logisticians to maintain situational awareness throughout the entire distribution network. These Log IT systems are a necessary tool for Marine logisticians to properly plan for supporting tactical level operations. Moreover, accurate information is key to proper planning and must be provided by Log IT systems as designated within MCBUL 4081.

2. MCBUL 4081: MAGTF Logistics Support Systems (MLS2)

MCBUL 4081 was released in May of 2012. The purpose of the bulletin is to provide guidance on approved MLS2 for use within the MAGTF. This bulletin contains

over 54 Log IT systems and applications that are used to fill in information gaps essential for Marine logisticians to perform his or her job (DON, 2012). This is an overwhelming amount of IT systems for any user to monitor. Additionally, MCBUL 4081 provides definitions and capabilities of each Log IT system but does not define how these Log IT systems will be used within the organization in support of operations. Figure 1 is a systems diagram of how MLS2 systems should be used at the tactical level provided by the MLS2 Project Manager, Log IT Systems, Marine Corps Systems Command (MARCORSYSCOM).

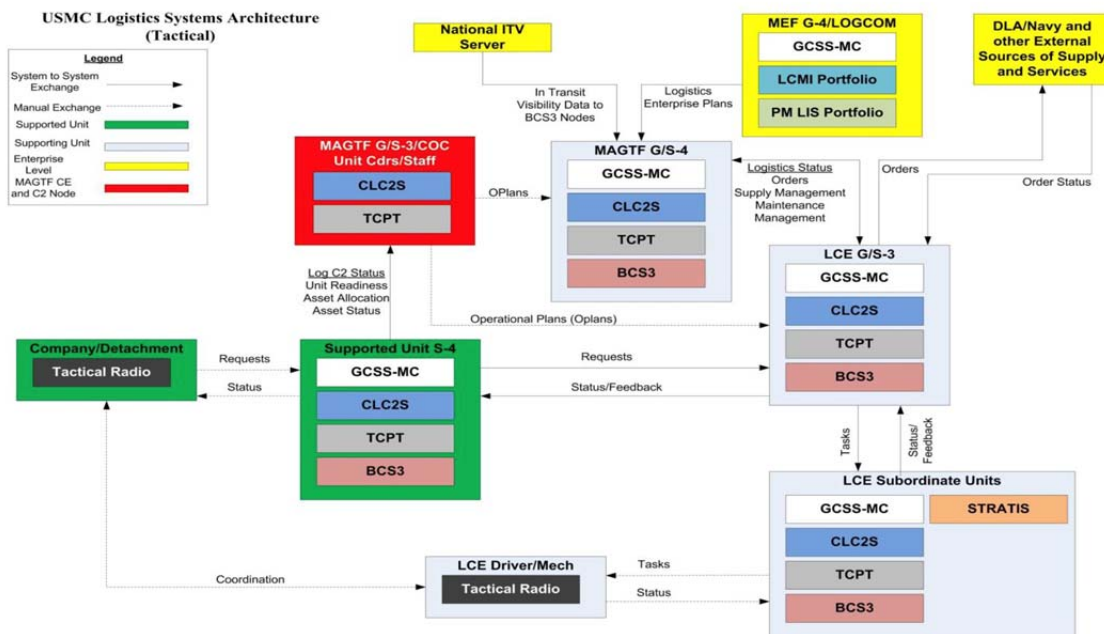


Figure 1. USMC Logistics Systems Architecture.
Source: R. Barber, personal communication, June 30, 2014.

The different components that are included in this systems diagram are Log IT systems, organization, and feedback loops. Currently, this systems diagram is not enforced as a standard across the organization. This diagram is only a recommendation on how units should be using their Log IT systems to communicate and perform logistical functions in support of operations.

3. MCO 4000.51: Automatic Identification Technology (AIT)

MCO 4000.51: AIT was published in 2013 with the purpose of establishing policy regarding the use of AIT within the organization and to define the suite of technologies that support automatic information systems (AIS). According to the AIT policy, these technologies include “linear barcodes, two-dimensional (2D) barcodes, magnetic strips, integrated circuit chips (ICC), optical memory cards (OMC), radio frequency identification (RFID) (active and passive), and contact memory buttons (CMBs)” (DON, 2013, p. 1). This MCO mandates which AIT is to be used in concert with AIS to capture and transfer relevant data automatically within logistics systems while minimizing human interaction. When used appropriately, AIT can reduce manpower requirements for tracking equipment and personnel as well as increasing situational awareness by populating relevant fields within AIS passively and actively.

While AIT is a force multiplier and essential in the distribution process, this policy does not direct which AIS will be used with AIT. This policy also does not provide a systemic design on implementing AIT. For example, Commanders of Marine Corps Forces are each tasked with developing and implementing internal procedures to mandate operational use of AIT. Again, the lack of standardization negatively impacts situational awareness because whether or not a unit can capture relevant information depends on whether or not they use AIS. In addition, the individual commander determines relevant information, but this information does not necessarily come from AIT and AIS. For example, most tactical units use Microsoft Excel spreadsheets to track equipment due to reduced bandwidth connectivity while deployed in austere environments. This practice does not encourage or facilitate the successful implementation of MCO 4000.51: AIT, nor does it provide the necessary information for the Marine Corps distribution process as described in MCO 4470.1A: USMC MAGTF Deployment and Distribution Policy (MDDP).

4. MCO 4470.1A: USMC MAGTF Deployment and Distribution Policy (MDDP)

Released in 2014, MCO 4470.1A: USMC MAGTF Deployment and Distribution Policy (MDDP) defines the roles and responsibilities of MDDP elements to establish an integrated method of managing transportation and supplies. This document created a new organization, the MAGTF deployment and distribution operations center (MDDOC), who is given the responsibility to “conduct integrated planning, provide guidance, coordinate, and monitor transportation and inventory resources as they relate to the management of the MAGTF’s distribution process” (DON, 2014, p. 10). In order to accomplish these tasks, the Marine expeditionary force (MEF) is tasked with creating standard operating procedures (SOP) for the MDDOC. Separate SOPs for each MEF does not facilitate a streamlined distribution system to improve logistics effectiveness. Additionally, the MDDOC serves to coordinate and monitor transportation, but does not have authority to control these separate unit movement control centers (UMCC) at the MSC level such as the Marine air wing (MAW).

5. Theater Battle Management Core System (TBMCS)

The Marine aviation community uses Theater Battle Management Core System (TBMCS) to maintain situational awareness of passengers and cargo moving via aircraft in accordance with current wing procedure manuals (WgPM) such as WgPM 3000.1: 3d Marine Air Wing (MAW) Battlestaff Standard Operating Procedure (SOP) (2015). This SOP mandates the use of this system within the MAW. The tactical air command center (TACC) utilizes TBMCS and is physically separate from the ground logistics element. Within the MAGTF, Air officers are assigned to each of the MAGTF command elements and provide guidance on how to request Marine aviation assets for coordinating activities across the different elements of the MAGTF. Unfortunately, Air officers typically have neither the access to TBMCS nor the authority to task aircrafts in support of logistics missions. Furthermore, TBMCS is not designed to provide transportation metrics for Marine logisticians because it is not a designated Log IT system. As a result, TBMCS is not aligned to the overall Log IT Portfolio Strategy for modernizing logistics.

6. Logistics Information Technology (Log IT) Portfolio Strategy

Accurate information is the key to proper planning. The Marine Corps has outlined its key objectives for improving information sharing through the Logistics Information Technology (Log IT) Portfolio Strategy. Published in 2014 by Deputy Commandant, Installations and Logistics (DC,I&L) Lieutenant General (Lt Gen) Faulkner, this policy is aimed at providing guidance on Log IT systems that supports the future operational requirements described in EF21 within a fiscally constrained environment. These objectives include transitioning the logistics community into a knowledge-based element in the Operating Force and Supporting Establishment to achieve decision and execution superiority. The Marine Corps published its Log IT Portfolio Strategy to emphasize that objectives will be achieved across two main components: 1) MAGTF logistics support systems (MLS2) and 2) enterprise logistics support systems (ELS2) (HQMC, 2014b, p. 3). Using these two components greatly enhances horizontal communication across all units and additionally provides a total asset and in-transit visibility (ITV) capability.

The Log IT Portfolio Strategy is an effort to synchronize efforts to modernize logistics processes. The key vision of the document is that Log IT systems can meet emerging operational requirements defined in EF21 within a fiscally constrained environment (HQMC, 2014b, p. 3). In order to readily deploy units, while also managing costs, it is essential that the Marine Corps establish an effective portfolio management construct (HQMC, 2014b, p. 7). This vision aims to “achieve an interoperable Log IT portfolio that provides a more integrated and scalable end to end logistics chain management” (HQMC, 2014b, p. 8) using MLS2 so that the right people get the right information at the right time. The Logistics Plans, Policy and Strategic Mobility Division are tasked with implementing this vision. While this strategy is a step in the right direction towards effective management, it does not include integrating IT systems for Marine aviation. Without integrating Marine aviation at the tactical level, the MAGTF commander’s situational awareness will be impeded concerning how his transportation assets are being used in support of logistics. Therefore, Marine logisticians will still be

limited to primarily conducting distribution via ground transportation and only requesting air when required.

B. CHALLENGES OF IMPLEMENTATION

An unsynchronized approach to logistics modernization presents several challenges when implementing policies across the organization. These challenges include a lack of standard procedures, formal reports and integration. Reviewing these challenges is valuable because the researchers identified gaps on the current system and recommend a way forward. This analysis frames the discussion in Chapter III, which applies the systems thinking methodology and creates a proposed systemic structure in order to increase Marine logistician's ability to meet the logistics goals outlined in EF21.

1. Lack of Standard Procedures

All six of these policies discussed in this thesis provide guidance on logistical processes and mandates which Log IT systems will be used by Marine logisticians in a centralized fashion. However, these documents do not provide a systemic approach on how these Log IT systems will be used by Marine logisticians at the operational and tactical levels. Furthermore, the researchers only analyzed six policies to provide the reader an idea of the issue but could include several more on the same topic. As a result of not applying a systemic approach, these documents are not interrelated and could potentially provide conflicting guidance. In addition, this loose guidance is counter to a strict mechanistic design, which enforces rules, regulations and standard procedures by using formal systems (Daft, 2013, p. 31). In order to maintain continuity, standardization and facilitate proper chain of communication and guidance, it is necessary that formal systems in place work congruently with policy. Without standard procedures, logistics modernization efforts will continue to be implemented in an unsynchronized manner across the Marine Corps.

2. Lack of Formal Reports

Furthermore, some of these Log IT systems have redundant capabilities. This lack of standardized processes increases the complexity in an already dynamic environment,

thus increasing uncertainty in the environment. HQMC, I&L is unable to efficiently “manage information, guide communication and detect deviations from established standards and goals” (Daft, 2013, p. 31) because there are no formal systems placed at the operational and tactical levels. This thesis will review MLS2 systems for transportation at the tactical level because these are systems that HQMC, I&L has mandated to be used at the tactical and operational level in accordance with LOGMOD initiatives until GCSS-MC is fully mature (HQMC, 2005). In particular, the MLS2 system this thesis will study is TCPT. The benefit of requiring formal reports from Log IT systems is that this practice ensures and enforces that units will use these Log IT systems for tracking their transportation metrics. Additionally, formal reports measure the established standards and goals of the strategic level (Daft, 2013, p. 31). Formal reports generated from Log IT systems are not a requirement in the current Marine Corps guidance.

3. Lack of Integration

LOGMOD identified the need to streamline the distribution system in order to improve logistics effectiveness within the Marine air-ground task force (MAGTF). According to Marine Corps doctrinal publication (MCDP) 4-0 Logistics, every logistics system has two fundamental elements: a distribution network and command and control (C2) (HQMC, 1997). Currently, there is no single process owner for the distribution network or command and control (C2).

In order to streamline transportation and supply, Marine logisticians must be able to use one system to generate requirements, process requests and task ground and aviation units to support. Currently, Marine logisticians use multiple systems including TCPT, CLC2S, and GCSS-MC to monitor requests and task units to support via ground transportation. On the other hand, Marine aviators use TBMCS to track aircraft passengers and cargo and Marine logisticians do not use this system on a daily basis. Multiple process owners further complicate streamlining support to the MAGTF as each entity has competing requirements as well as impacting the quality of information processed in the Log IT systems.

C. GAP ANALYSIS AND WAY FORWARD

For this thesis, the researchers apply a systems thinking methodology using three components: 1) organization design, 2) IT systems and 3) feedback control. By structuring these components across the Marine Corps, Marine logisticians can achieve LOGMOD initiatives and the two goals of expeditionary logistics for EF21. This thesis demonstrates that applying a systems thinking approach will increase the MAGTF commander's situational awareness by developing an application that can be used by the MAGTF CE S-4. This application will provide the MAGTF CE S-4 the necessary information to make a decision and provide recommendations on transportation assets based on metrics.

1. Gap Analysis

Currently, there is no standard methodology the Marine Corps uses to assess whether or not logistics modernization policies are successfully being implemented across the organization. There is also no standard structure that exists for how the different units within the Marine Corps use Log IT systems, which creates gaps in collecting data and providing analytics in meeting strategic goals. Furthermore, there is no web application that provides Marine logisticians with an integrated view of both air and ground transportation metrics. Without this knowledge, it is difficult for Marine logisticians to properly plan and make changes based on feedback concerning how transportation assets are being used to support the MAGTF. This thesis addresses these gaps by applying a systemic approach to the MAGTF in Chapter III and demonstrating the usefulness of this methodology in phase two of the thesis, which encompasses Chapter IV and Chapter V.

2. The Way Forward

The proposed application developed in this thesis demonstrates how applying a systemic approach when implementing IT systems, promulgating policy and recognizing organization structure is necessary for organizational effectiveness and efficiencies. As previously discussed, the current IT system structure was not built with respect to the organization design, which creates gaps in the commander's situational awareness.

Therefore, the application model developed in this thesis is a proof of principle to provide an integrated view for the commander by pulling the necessary information from these disparate IT systems at the appropriate level of organization. The web application is the Transportation Capacity Tool, which pulls information from two existing databases, TCPT and TBMCS, for use at the tactical level. The researchers show the usefulness of this application in Phase two of this thesis by studying a use case centered on MAGTF transportation assets, particularly air and ground assets. By having access to this information, the application can be used by the MAGTF commander to increase decision-making and logistics effectiveness within the organization.

Chapter III provides the reader with an introduction to systems thinking methodology and defines three components that apply to the MAGTF system: 1) organization design, 2) IT systems and 3) feedback control. These components are applied to the different levels of war and reveal the interrelationships between the activities, which needs to be considered when promulgating policy or making a change. After defining the MAGTF in terms of a systemic approach, the researchers provide a proposed systemic structure that can be used to successfully meet logistics modernization goals in a more efficient and effective manner.

III. APPLIED SYSTEMIC APPROACH TO THE MAGTF

This chapter approaches logistics modernization from a systems thinking perspective in order to achieve the logistics principles set forth in EF21. This chapter addresses the three components of the system: 1) organization design, 2) IT systems and 3) feedback control. Section A and B define organizational design and applies the appropriate design to each level of war. Section C reviews why it is important to apply the appropriate organization design when using IT systems and Section D identifies the specific IT systems that will be used for capturing transportation metrics. Section E covers the last component of the systemic methodology and explains how feedback mechanisms within Log IT systems increases situational awareness at the tactical level and provides the necessary information for the MAGTF commander to make an enhanced decision. Finally, Section F is a proposed systemic structure that can be utilized for implementing logistics modernization efforts within the organization and successfully meet Marine Corps strategic goals.

A. ORGANIZATION DESIGN

In organizational theory, there are two different design approaches: 1) mechanistic and 2) organic. Figure 2 is a diagram that depicts the characteristics of organization that have mechanistic and organic designs.

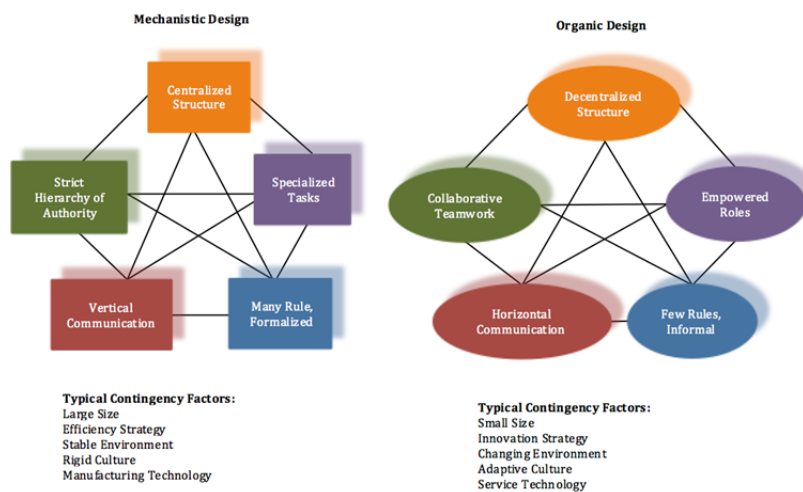


Figure 2. Organic and Mechanistic Design. Source: Daft (2013), p. 31.

Using these two different organizational designs applied to the different levels of war is valuable because it ensures that the organization is able to successfully meet their goals. Based on the contingency factors of the organization, the appropriate design will dictate which type of IT system should be used to meet strategic goals. For instance, the mechanistic design allows an organization to operate more efficiently, whereas an organization that has an organic design operates more innovatively. Since the Marine Corps operates and deploys in a variety of environments, the researchers review the benefits of each design related to efficiency in the next section.

1. Organization Design Related to Efficiency

Analysis of the hierarchical structure reveals that the Marine Corps is inherently centralized in accordance with a mechanistic design; however, the MAGTF is designed to conduct decentralized operations in accordance with an organic design. Decentralization places decision-making authority at the lowest levels in order to respond to environmental changes (Daft, 2013, p. 30). Decentralization also increases organizational efficiency because it facilitates rapid adaption to change (Daft, 2013, p. 98). For an organization to achieve its strategic objectives, it is important to understand the environment that influences the internal workings. Efficiency as it is related to each organizational design is shown in Figure 3.

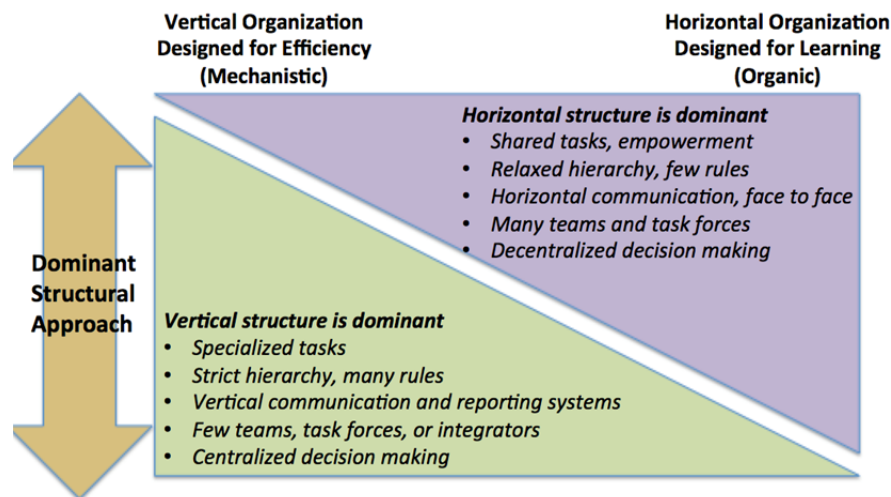


Figure 3. The Relationship of Organization Design to Efficiency versus Learning Outcomes. Source: Daft (2013), p. 98.

The MAGTF operates in a complex and highly unstable environment, but this environment is further exacerbated during deployment. Depending on the fluidity of the deployment, high uncertainty will pervade based on the amount of information that will need to be constantly updated. An organization that is successfully able to adapt to these rapid changes will apply an organic design instead of a mechanistic design. Currently, the Marine Corps has implemented logistics modernization (LOGMOD) initiatives and passed guidance within its three different levels of war: strategic, operational, and tactical without respect to organization design. The next few sections are an overview of how the current design relates to the levels of war.

2. Strategic Level

At the strategic level, Headquarters Marine Corps (HQMC), Installations and Logistics (I&L) is responsible for disseminating policies and guidance on logistics and Log IT systems. HQMC, I&L has published several policies concerning the distribution process and the use of Log IT systems in accordance with the shared vision of EF21 and LOGMOD. These policies include Marine administrative message (MARADMIN) 444/05, Marine Corps bulletin (MCBUL) 4081: MAGTF Logistics Support Systems (MLS2), Marine Corps order (MCO) 4000.51: Automatic Identification Technology (AIT), MCO 4470.1A: USMC MAGTF Deployment and Distribution Policy (MDDP), and Logistics IT Portfolio Strategy.

3. Operational Level

At the operational level, Marine expeditionary forces (MEF) are responsible for creating standard operating procedures (SOP) to implement these policies. Currently, within the Marine Corps there are four different MEFs geographically separated around the world. Based on these locations, the MEFs operate independent of one another based on the knowledge and experience of the Marines that have been stationed at these units. At this level, the MEFs can use Log IT systems as they see fit as long as they are in compliance with the published policy.

4. Tactical Level

At the tactical level, the MAGTF is responsible for executing tasks according to the guidance provided by policy from the strategic level and SOPs that are approved at the operational level. Currently, the MAGTF is deployed in a standard structure that include elements such as the command element (CE), ground combat element (GCE), air combat element (ACE), and logistics combat element (LCE). The MAGTF can be sized accordingly with the need of supporting operations. At this level, the MAGTF has the ability to choose which Log IT systems they will leverage as long as they are in compliance with the published policy and meet the information requirements dictated at the operational and strategic levels.

B. APPLYING ORGANIZATIONAL DESIGN TO LEVELS OF WAR

This section defines the different levels of war in terms of organization design. This provides the reader an idea of how Log IT systems can be used to meet logistics modernization goals by implementing the appropriate design. The two organizational designs are mechanistic and organic (Daft, 2013, p. 31). The authors apply these two designs to the strategic, operational and tactical level of war and discuss the flaws of not applying a mechanistic or organic design to the organization.

1. Mechanistic Design

As depicted in Figure 2, a mechanistic design is defined by a centralized structure. As such, the organization operates with a strict hierarchy of authority through vertical communication. The mechanistic design has many rules that are formalized through guidance. Last, a mechanistic design has units with specialized tasks that remains in a stable environment. The contingency factors for a mechanistic design are large size with a stable environment and rigid culture (Daft, 2013, p. 31). Based on this definition, the researchers apply this design to the strategic and operational levels of war.

a. Strategic Level

At the strategic level, the Marine Corps is a large, centralized organization with vertical information flow and a strict hierarchy of authority. The Marine Corps has many

rules, which are formalized over policy and guidance. All of these characteristics mean that at the strategic level the Marine Corps has a mechanistic design. An organization with a mechanistic design publishes guidance from the top-down. When implementing change, the top-down management will create a vision as a solution to the problem. In his book, *The Fifth Discipline*, author Peter Senge (1990) asserts, “[b]uilding shared vision must be seen as a central element of the daily work of leaders” (p. 214) because it provides purpose and core values to the organization. Shared vision is a product of key stakeholders across all levels of the organization, but it is not always shared nor implemented successfully.

b. Operational Level

At the operational level, there are many different organizations within the Marine Corps such as the Marine expeditionary force (MEF) or the Marine component command within a geographic command. This study reviews the MEF in relation to the MEU. According to MCO 4470.1A, the MEF is tasked with providing standard operating procedures (SOP) for its subordinate commands to ensure that the distribution process is successfully executed at the tactical level. In addition, the MEF is tasked with training, staffing and equipping the MAGTF deployment and distribution operations center (MDDOC) to implement policy (DON, 2014).

This direction is structurally complex because the Marine Corps is organized into four different MEF commands that are each tasked with publishing separate SOPs. In order to successfully implement change, the policies and procedures need to be standardized in a hierarchical structure due to high uncertainty of information received across the organization in accordance with a mechanistic design (Daft, 2013, p. 98). Also, the mechanistic design requires that HQMC, I&L provide a standardized formal system to support efficiency as competing requirements will impede future funding for logistics modernization (Daft, 2013, p. 98).

Future funding of Log IT systems is dependent on performance of the system. This is difficult to capture because each MEF uses the MLS2 systems in a different manner and may prefer one Log IT systems to another. This practice of MEF’s

customizing the use of MLS2 systems within the MAGTF will adversely impact future funding for Log IT systems as contracts are renewed or re-competed according to each MEF's preferences and recommendations. On the other hand, rather than continuing to facilitate each MEF's customization of Log IT systems, these funds could be reallocated to further develop GCSS-MC into a more effective tool for Marine logisticians vice other MLS2 systems.

2. Organic Design

An organic design applied to the Marine Corps at the tactical level increases efficiency. As developed by Daft (2013), "an organic design is characterized by a decentralized structure, empowered roles, informal systems, horizontal communication and collaborative teamwork" (p. 36). Daft (2013) lists the contingency factors of an organic design as "small size, innovation strategy, changing environment, adaptive culture and service technology" (p. 31). Essentially, the MAGTF is a decentralized structure of the Marine Corps because it is comprised of the essential elements to successfully accomplish its mission with little outside support. The MAGTF contains the command element (CE) who tasks and collaborates with the air combat element (ACE), logistics combat element (LCE) and the ground combat element (GCE) to achieve their mission.

a. Tactical Level

The MAGTF is the organization at the tactical level of war. The MAGTF is the organization that will be executing the distribution and transportation process using written policy to perform their daily functions in accordance with guidance received from the MAGTF commander. The MDDOC is the entity that will be providing this function for the MAGTF. MCO 44170.1A provides an organizational diagram of how the MDDOC should be structured within a garrison and deployed environment. The structure for the deployed MDDOC is included as Appendix A for reference. This diagram is extremely useful as it provides a standard structure so that each MEF can provide the same information across the same levels.

Standardization makes it easier for information to be collected at the strategic and operational level of war and used for analysis in order to make the distribution process more effective and efficient. However, the organizational diagram in Appendix A has some flaws. For example, MEF's are not mandated to follow this structure as it is a recommendation only. Additionally, this organizational diagram does not provide a systemic framework of components such as the horizontal and vertical interrelationships with the tactical units and the Log IT systems that each element uses for performing their function. Therefore, it is difficult to pinpoint which levers of the system will need to be adjusted based on lack of information flow and feedback mechanisms. The next subsection reviews why applying the organic design at the tactical level for the MAGTF provides many benefits to the commander.

b. MAGTF

The MAGTF does operate with collaborative teamwork because the ACE, LCE and GCE all interact with the CE and each other in order to accomplish their tasks. Empowered roles are encouraged at the MAGTF as units typically have decreased layers of hierarchy in order to get the support necessary to conduct operations in a rapid manner. Horizontal communication refers to the communication that happens across the organization. This also occurs at the MAGTF as the ACE, GCE and LCE have special relationships to provide support to one another. A prime example of this is the direct support (DS) combat logistics battalion (CLB) and the regimental combat team (RCT). This information flow is horizontal because each entity is working together to accomplish the same goals during an operation without having to get direction or approval from the CE in a vertical fashion.

Finally, an organic design has few rules and is informal. This is also true of the MAGTF to an extent. While the MAGTF does have a formal SOP that describes the internal workings of the unit, the SOP constantly is being refined based on what works and the organizational and personal relationships developed during the deployment. The MAGTF uses collaborative teamwork and horizontal communication when developing internal and external working relationships. In this sense, the MAGTF is extremely

adaptive because it follows the organic design (Daft, 2013, p. 31). The MAGTF also shares many of the contingency factors of an organic design.

As previously listed by Daft (2013), the contingency factors for an organic design are “small size, innovation strategy, changing environment, adaptive culture and service technology” (p. 31). The MAGTF is unique since it can be sized according to the need, although generally small in nature to enhance flexibility. The MAGTF is innovative when overcoming challenges. For example, the proof of principle (PoP) applied by the 11th MEU reduced the customer wait time by introducing a new distribution liaison cell (DLC) to improve material throughput. The MAGTF is constantly changing their environment through deployment or crisis response. Based on an organic design, the MAGTF will employ a service technology for Log IT systems, which is characterized by intangible outputs, rapid response times and the importance of the human element amongst other characterizations (Daft, 2013, p. 277).

C. IT SYSTEMS APPLIED TO ORGANIZATIONAL DESIGN

Since the MAGTF has an organic design and the type of technology that is appropriate to meet the environmental demands is a service technology, the system thinker must consider how the factors of organizational design, environment and technology are interrelated. These factors are interrelated using logistics information technology (Log IT) that is relationally structured based on the MAGTF design. In Marine logistics, MCBUL 4081 provides a list of 54 different Log IT systems that are used for tracking logistical functions. Organization efficiency is defined as the amount of resources used to produce a unit of output within the internal workings of an organization (Daft, 2013, p. 71). In order for an organic design to be efficient, it is imperative that the organization reduces the amount of IT systems that are in use.

The MAGTF could reduce the amount of Log IT systems it uses for logistics, but this needs to be facilitated by the operational and strategic levels through updated policy, procedures and Marine Corps orders (MCO). For example, HQMC released MARADMIN 331/15 in July of 2015 and recently mandated that all requirements for materials and services will be ordered by all units using GCSS-MC or purchase request

builder (PRB) in order to improve visibility and accountability of requisitions (HQMC, 2015). This is an improvement in increasing effectiveness; however, units can still request services and supplies through CLC2S and TCPT instead of GCSS-MC. In order to be most effective across the organization, GCSS-MC needs to be further developed to facilitate units ordering all classes of supply using only one system that captures information requirements.

The Log IT system needs to be built in order to facilitate the organizational design. This research aims to create a dashboard using the Log IT systems in place to gather information on transportation. This research is focused on transportation at the MAGTF level because this is an opportunity to provide greater enhancements to horizontal communication across the organization at the tactical level as dictated by an organic design. The specific elements that will be enhanced are ground and air transportation as a result of increasing horizontal communication from the ACE, GCE and LCE using a dashboard. This will facilitate greater situational awareness at the tactical level. Moreover, this research aims to measure how effectively the stakeholders will use this Log IT system specifically the MAGTF CE S-4 since he or she will benefit most from an application that provides transportation metrics.

D. IT SYSTEMS FOR TRANSPORTATION

Given the amount of Log IT systems identified as MLS2 within MCBUL 4081, this research is appropriately scoped to only include relevant Log IT systems used for capturing transportation within a MAGTF. At a minimum, the researchers have identified the following Log IT systems for transportation as CLC2S, TCPT and GCSS-MC as these systems are designated MLS2 and critical components of the logistics operational architecture (Log OA). By integrating the aviation component, the researchers have also identified TBMCS as an IT system that will need to be monitored for tracking cargo and passengers transported on Marine aviation assets at the tactical level. The intent of this section is to provide an overview of the capabilities and limitations of each of these systems to the warfighter within the context of the Log OA.

1. GCSS-MC

GCSS-MC is considered to be the practical implementation of the Marine Corps' Log OA, which standardizes the implementation of Marine Corps-wide processes for logistics and related IT enablers. It is also an enterprise system, which is defined as "a set of information systems tools that many organizations use to enable information flow within and between processes across the organization" (Pearlson & Saunders, 2013, p. 110). As an enterprise system, GCSS-MC should be the only Log IT system that users need to access for information; unfortunately, GCSS-MC is still being developed and future increments will provide these capabilities. As a result of future planned development, Marine Logisticians currently use GCSS-MC coupled with the 53 other MLS2 systems to support operations (DON, 2012).

GCSS-MC includes many features that are beneficial for the Marine logistician, but it also needs to be improved. According to the 24th MEU, GCSS-MC was a secondary means of ordering high priority material because of connectivity issues and reduced functionality. For example, Marines on the USS NEW YORK did not have GCSS-MC functionality 60 days into the deployment, greatly reducing their ability to perform decentralized tasks within the Log IT system and negatively impacting their situational awareness (24th MEU, 2015). Additionally, Marines cannot use GCSS-MC on a SECRET network, which is not conducive to maintaining an advantage over potential adversaries. Based on these two reasons, this research focuses on demonstrating how the MAGTF CE S-4 can use TCPT and TBMCS as a means for providing transportation analytics.

2. MLS2 Systems

Both TCPT and CLC2S are designated MLS2 systems and are viable systems for use by Marine Logisticians. Both of these Log IT systems can be used on a SECRET network and can provide automated reports based on what the user needs. Individual MAGTFs can determine which system they prefer to use, but most units typically use both systems. Most units use both systems because all of these systems combined give the commander more information. Furthermore, both of these Log IT systems are advertised as a tool to provide the commander a logistics dashboard to aid in decision-

making. Both Log IT systems can also be used with GCSS-MC to provide the user with increased functionality (DON, 2012). For the purposes of this research, the authors have scoped the use case to only include information pulled from TCPT from the MLS2 suite of systems because this Log IT system provides more detailed information on transportation metrics. When used in conjunction with TBMCS, the commander will get a more accurate picture of the organic transportation assets with the least amount of systems.

3. TBMCS

Last, this research focuses on using TBMCS within the MAGTF CE S-4 because this is the IT system used by the Marine air wing (MAW). TBMCS is useful because it provides information on passengers and cargo traveling via Marine aircraft. Additionally, it produces the air tasking order (ATO), which can be used by the MAGTF CE S-4 to move high priority items on short timelines or it can be used to track and verify cargo and passengers moving on Marine aircraft. Another advantage is TBMCS is a joint system and is used on a SECRET network. In short, having access to this IT system provides Marine logisticians another tool for successfully supporting the warfighter in a deployed environment.

For instance, the 24th MEU CE successfully leveraged organic MEU aviation assets by coordinating face to face with the Navy and 24th MEU ACE in formal meetings. As a result of increased situational awareness, the 24th MEU increased throughput and alleviated cargo buildup. The 24th MEU CE also reduced the amount of time for moving high priority items by reviewing flight schedules, conducting prior coordination with the MEU ACE and leveraging the MV-22 Osprey which is an aircraft characterized by its superior speed and range (24th MEU, 2015). While formal meetings are beneficial, the MAGTF CE S-4 will be better able to plan in advance and coordinate with the MAGTF ACE by having access to TBMCS. Furthermore, the MAGTF CE S-4 could use TBMCS in order to have access to the most updated information on air operations thereby facilitating enhanced decision-making.

4. Importance of Metrics

Using IT systems provides Marine logisticians accurate and updated information quickly, which is critical for planning operations and managing resources. By ensuring the MAGTF CE S-4 appropriately leverages these IT systems, Marines will become more effective and efficient logisticians in a MEU environment as mandated in EF21. In order to appropriately leverage these systems, strategic and operational guidance needs to establish metrics of performance for the tactical level. As stated in the 24th MEU after action report (AAR), metrics of performance were key to ensuring Marines at the tactical level could monitor, assess and improve performance during the deployment (24th MEU, 2015). Therefore, it is necessary to define the last component of the MAGTF system: feedback control.

E. FEEDBACK CONTROL MODEL

The purpose of the feedback control model is to determine whether or not the organization meets established standards to attain their goals (Daft, 2013, p. 314). The diagram depicted in Figure 4 are the inputs necessary for an organization to consider when taking corrective action and adjusting goals (Daft, 2013, p. 314).

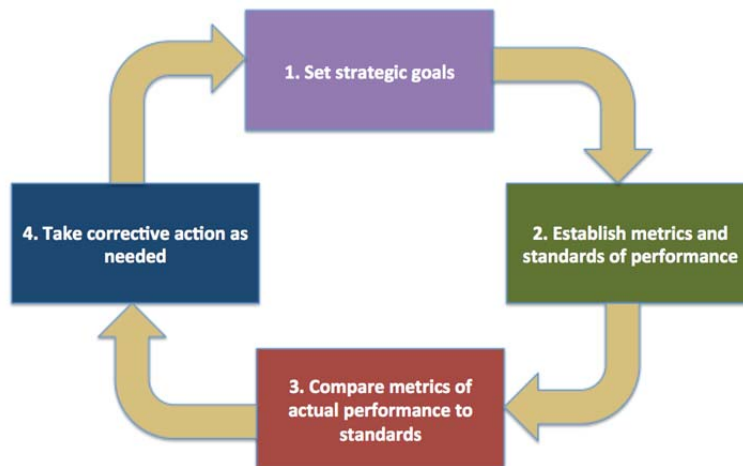


Figure 4. A Simplified Feedback Control Model. Source: Daft (2013), p. 314.

Within the Marine Corps, LOGMOD initiatives are the overall strategic goals as established by HQMC, I&L through several policies and Marine Corps orders (MCO), which is step one of the feedback control model. Unfortunately, strategic goals are the extent of the feedback control model for the MAGTF. Applying the feedback control model to the MAGTF, there are no formally established metrics and standards of performance, which is step two of the model. Without these metrics, Marine logisticians at the tactical, operational and strategic level will not be able to compare performance and take corrective action as needed for steps three and four of the model. Without the ability to compare performance output to take corrective action, organizational efficiency will be impeded and change cannot be implemented successfully. To be successful, leadership will need to be involved in receiving and providing recommendations on feedback and by using defined metrics of performance.

Metrics of performance are essential in changing an organization. A successful example of this is the 11th MEU deployment from July 2014 to February 2015 using customer wait time as a metric of performance. Working with HQMC, I&L the 11th MEU implemented a proof of principle and changed their structure in order to better handle material throughput using distribution liaison cells (DLC). Using customer wait time, the 11th MEU realized that by placing DLC Marines at key logistics infrastructure nodes ahead of schedule they were able to reduce customer wait time. According to the 11th MEU Post Deployment Brief, customer wait time for priority 02 items were reduced from an average of 45 days down to 8 days and priority 05 items were reduced from an average of 90 days down to 19 days (personal communication, 2015). Due to the organic design of the MEU, 11th MEU was able to change their structure and adapt to the environmental changes rapidly. Also, the informal structure gave them the ability to use their Marines in a different manner than previous MEUs. This is an excellent example of a unit with an organic design using information from Log IT systems as metrics of performance and analyzing the appropriate levers of change within the organizational system.

The 11th MEU was able to successfully change by embracing the qualities of an organic design; however, this change may be only effective for the duration of the 11th

MEU deployment if it is not formally captured through standard operating procedures. Therefore, learning in the organization is might be only effective for each individual unit because change is not formalized for successive MEUs. Learning is encouraged in an organic design and is facilitated with decentralization but learning is counter to a mechanistic design and impeded with centralization. In order to effectively meet LOGMOD initiatives as published by HQMC, I&L, it is necessary to apply a systems approach and leverage the appropriate levers within the construct once these levers are identified.

F. PROPOSED SYSTEMIC STRUCTURE

Tying all of these concepts together and applying a systemic approach to the MAGTF, the researchers developed a proposed systemic structure in order to successfully meet logistics modernization goals. This systemic structure includes: 1) organizational design applied to each level of war, 2) IT systems and 3) feedback control. Figure 5 is a proposed systemic structure for the MAGTF system.

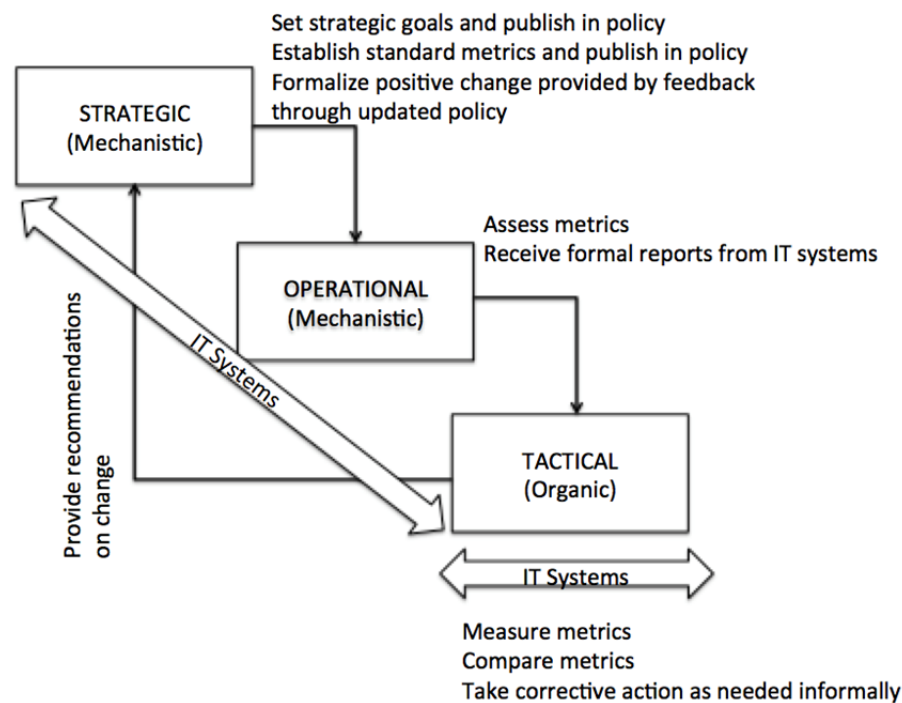


Figure 5. Proposed Systemic Structure. Source: Capt Sarah Bergstrom, 2015

As shown in Figure 5, an organizational design applied with respect to the IT system at each level of war facilitates rapid vertical and horizontal communication within the organization. Furthermore, the IT system can be used to provide feedback at each level of war, which is valuable for assessing logistics modernization efforts.

Within the framework of this proposed systemic structure, this research focuses on the MAGTF CE S-4 located within the MEU in order to measure metrics of transportation for both air and ground assets. These metrics will be compared and the MEU can adapt to the situation and take corrective actions as needed. By using Log IT systems to measure these metrics, the MAGTF CE S-4 will be more effective in using transportation assets. Also, by establishing formal reports the Marine Corps will increase vertical communication from the tactical to the strategic level.

Integrating both air and ground transportation assets from multiple IT systems, the Marine Corps will increase both horizontal communication and situational awareness across the organization. Once positive change occurs at the tactical level, the Marine Corps can successfully implement these changes through the strategic and operational levels in a centralized fashion, which in turn promotes learning and improvement meeting the objectives of logistics modernization and the logistics goals of EF21. The researchers have demonstrated that these objectives can be achieved through a systems thinking methodology, which is phase one of this thesis.

Phase two is the demonstration of this proposed systemic structure through a proof of principle web application. The proof of principle web application combines air and ground transportation assets and provides the MAGTF commander with transportation metrics. Chapter IV discusses the development tools used to create the application. Chapter V implements the web application through a use case provided by the sponsor that is based on a MEU scenario. Based on the feedback provided by the web application, the MAGTF commander is enabled to use his or her transportation assets more effectively and efficiently thereby achieving the objectives of logistics modernization.

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IV. DEVELOPMENT TOOLS AND APPLICATION METHODOLOGY

The next section of this thesis is the second phase in which the researchers develop a proof of principle web application that combines air and ground transportation assets. The purpose of this application is to show how a dashboard can increase horizontal communication within the organization and provide greater situational awareness for the commander. This application meets the goals of the feedback control model because it measures and compares metrics to allow for corrective action. The development and testing of this application, the Transportation Capacity Tool, will be the focus of the following two chapters.

In this chapter, the researchers discuss the Oracle products used to develop and test the application. These products were selected based on their availability, ease-of-use, and reusability, as well as Oracle products being used throughout the Marine Corps. This chapter is organized into five parts: Section A provides background information on the Oracle company; Section B summarizes the Oracle Fusion platform to include applications, middleware and architecture; Section C discusses the structured query language (SQL) developer; Section D discusses JDeveloper along with the application development framework (ADF) model; and Section E discusses the WebLogic server.

A. ORACLE BACKGROUND

Oracle began as a database software company and has emerged into a leader in cloud applications, platform services and engineered systems that provide the customer with a fully packaged bundle that simplifies portions of their IT systems (Hurd, 2014, p. 4). Oracle was founded in 1977 with the development of the first version of Oracle Database (Oracle, 2007, p. 26). Within six years, Oracle released the first relational database management system (RDBMS) that would run on mainframes, minicomputers and personal computers (Oracle, 2007, p. 29). Throughout the 1980's, Oracle continued to revolutionize the database industry with the first RDBMS to operate in a client/server environment (Oracle, 2007, p. 29). As Oracle progressed in the database industry, they

saw a need for enterprise applications that could utilize the Oracle Database. In 1990, Oracle introduced their first application release that was an accounting program that leveraged the new client/server computing environment (Oracle, 2007, p. 30). Over the next couple of decades, Oracle continued to improve on their database and application technologies with advanced features and increased security. Oracle earned the industry's first independent security evaluation, which it has maintained for decades, providing customers the assurance of its secure environment from a third-party agency (Oracle, 2007, p. 30). With all the advancements and leading-edge technology, Oracle is being used by 98% of Fortune 500 companies throughout the world (Oracle, 2016b).

The Marine Corps has used Oracle products on numerous occasions, but most notably as the foundation for GCSS-MC (Oracle AppAdvantage, 2013, p. 29). As discussed in the previous chapter, GCSS-MC is the Marine Corps' logistics IT system that integrated a multitude of legacy IT systems in order to improve their ability to plan and execute logistical support missions. The Marine Corps did this by leveraging Oracle Fusion Middleware and Oracle E-Business Suite applications to consolidate over 200 legacy IT systems into one integrated infrastructure (Oracle AppAdvantage, 2013, p. 29).

B. ORACLE FUSION

Oracle Fusion is a term used to describe Oracle's overarching standard technology stack that was built to support the next generation of business applications (Ronald, 2011, p. 5). Oracle Fusion is not a product or service, but rather a framework that encompasses three pillars of technology used to support applications deployed by businesses (Ronald, 2011, p. 5). These pillars include Oracle Fusion Applications, Oracle Fusion Middleware, and Oracle Fusion Architecture and are used in conjunction with each other in order to support all aspects of developing, deploying, securing, and managing applications (Ronald, 2011, p. 5). In using Oracle Fusion, developers have only one framework with which to work eliminating redundancy when using multiple products and ensuring interoperability throughout the entire development process.

1. Oracle Fusion Applications

Fusion applications are business tools produced by Oracle that provide customers with the ability to manage different areas including “Customer Relationship Management, Financial Management, Governance, Risk and Compliance, Human Capital Management, Procurement, Project Portfolio Management, and Supply Chain Management” (Ronald, 2011, p. 5). These tools are offered as modules and can be purchased by a customer based on their needs. Oracle also provides tools that allow businesses to develop their own applications to fit their needs. Those applications produced utilizing Oracle technologies are also considered a Fusion application and are developed and deployed in the same manner as Oracle’s business tools (Ronald, 2011, p. 5). The ability to build your own applications easily is especially intriguing to unique organizations such as the Marine Corps. The missions and tasks that the Marine Corps’ applications need to accomplish are not normally found in out-of-the-box solutions. Therefore, the ability to customize applications to fit the Marine Corps’ needs is essential to mission success. The application built for this thesis would be considered a Fusion application and is thus supported by Oracle Fusion.

2. Oracle Fusion Middleware

In order to properly run a Fusion Application, Oracle needed to provide the customer with the infrastructure to develop and deploy the applications. The Oracle Fusion Middleware is the platform on which all Fusion Applications run and it provides the customer with features such as application servers, security, and management capabilities (Ronald, 2011, p. 5). These features support the user through all phases of the application life-cycle which reduces the cost and complexity of building applications. The middleware supports both Oracle produced Fusion applications and customer-built applications (Ronald, 2011, p. 5). Figure 6 is an overview of the Fusion Middleware platform.



Figure 6. Overview of the Fusion Middleware Solution. Source: Oracle (2010).

3. Oracle Fusion Architecture

Oracle Fusion Architecture refers to the “blueprints” used to build Fusion applications on top of the Fusion middleware (Ronald, 2011, p.5). The architecture combines various technology principles to include service-oriented architecture (SOA) and Java Platform, Enterprise Edition (Java EE) in which Fusion Applications are built (Ronald, 2011, p. 5). By providing this architecture openly to the public, developers have a well-established and sophisticated foundation on which to build, greatly reducing interoperability problems while running applications in Oracle or, in conjunction with third-party platforms.

C. SQL DEVELOPER

Oracle SQL Developer is a development tool for the Oracle RDBMS environment. The SQL Developer module was developed to be used by a user at any level and provides a graphical user interface that improves productivity and simplifies

database tasks (Oracle, 2008, p. 1). SQL Developer was developed in Java and can be operated on Windows, Linux or Mac OS X making it a valuable tool for developers in different environments (Oracle, 2008, p. 1). This tool allows a user to connect to databases, view, create and modify database objects, and run SQL statements with ease (Oracle, 2008, p. 2). This thesis required the researchers to extract schemas and data from two different databases and combine them into one. Using SQL Developer made this process extremely easy because of its detailed user interface, help features, and data modeler feature. The researchers were able to gain a better understanding of how both TCPT and TBMCS databases were structured and functioned by using SQL Developer. Figure 7 is the SQL Developer main window's default settings that can be customized based on user needs.

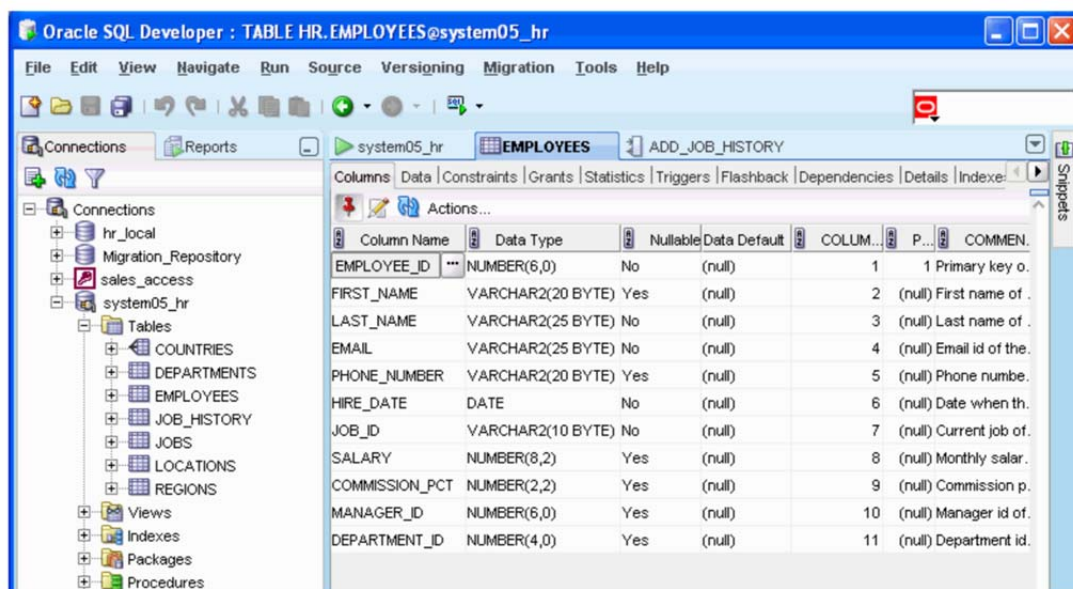


Figure 7. SQL Developer Main Window. Source: Oracle (2013).

D. JDEVELOPER

Oracle JDeveloper is a graphical interface tool used as the development environment for Oracle Fusion Middleware in which Fusion applications are built. It integrates features from Java, mobile, web services, and databases into one tool that covers the full development lifecycle of an application (Oracle, 2015, p. 1). JDeveloper

provides extensive features that support the writing, building and deployment of Java and web based programs (Ronald, 2011, p. 10). JDeveloper is a free tool and its user-friendly interface provides a simple environment to build applications. JDeveloper uses the ADF framework for the basis of application building. Figure 8 is a depiction of the JDeveloper integrated development environment (IDE).

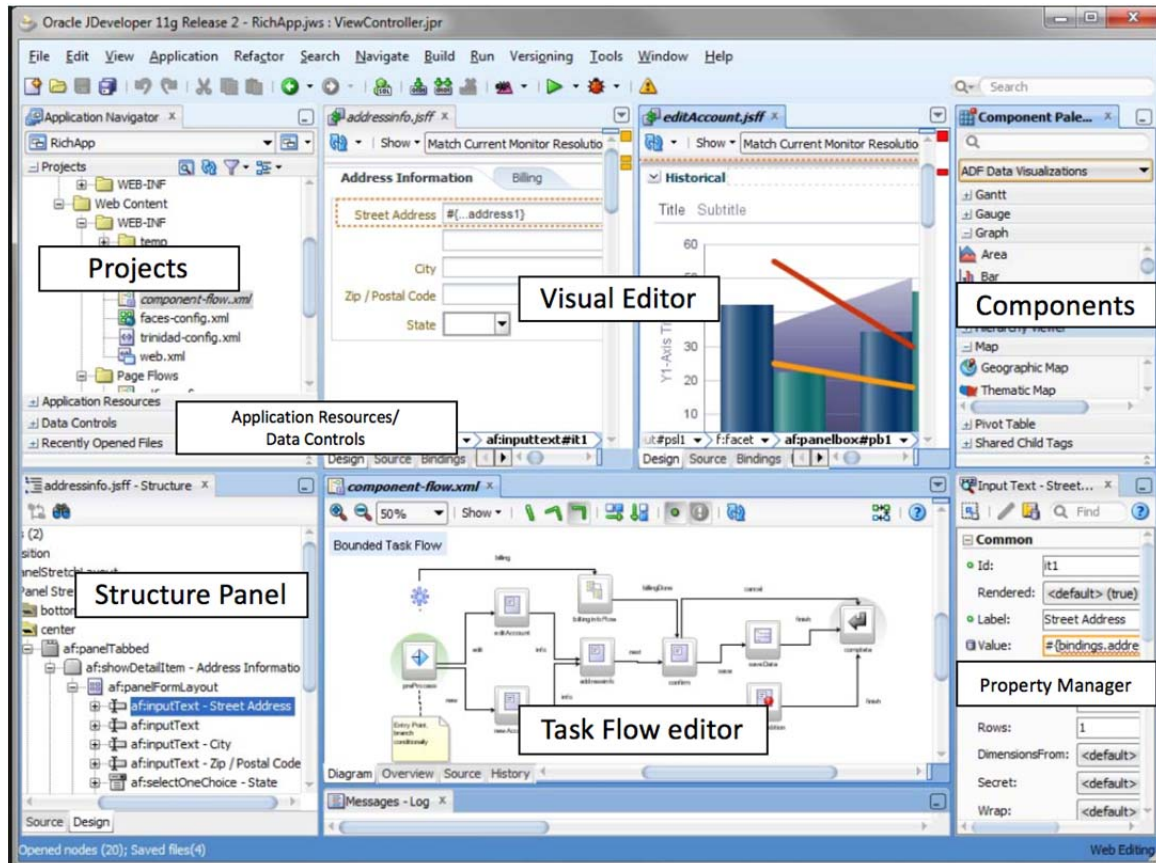


Figure 8. JDeveloper's Integrated Development Environment.
Adapted from: Ronald (2011).

E. ADF

Historically, the more complex the application, the more complexity required to build it. Today, Oracle's ADF framework allows users to build extremely powerful Java EE based applications with significantly reduced effort (Oracle, 2011, p. 1). The ADF framework, which is employed in JDeveloper, introduces visual and declarative methods,

along with the traditional way of building code, to build applications (Oracle, 2011, p. 2.). This allows users to utilize any or all methods to build applications depending on their skill level and abilities.

The ADF framework implements the Model-View-Controller architecture, which separates the application into three layers. The ADF framework further separates the model layer into a business services layer and a model layer. The model layer presents the data associated to the current page being accessed by binding it to the Business Services layer (Gordon et al, 2011, p. 54). The Business Services layer provides access to the data source as well as implements business logic (Gordon et al, 2011, p. 54). The view layer exposes the business services to the end-user through a graphic user interface (Ronald, 2011, p. 12). The controller layer represents the navigation of events and pages through the application (Ronald, 2011, p. 12). This architecture gives users the ability to work on each layer separately which simplifies application maintenance and allows for reuse of components across multiple applications (Oracle, 2011, p. 3). For example, an application could consist of multiple pages that all require a similar feature such as login. The user can build a login task flow which encompasses aspects from all layers and reuse this feature on all pages. This greatly reduces development time but also improves maintenance. The user would only need to update the login task flow and it would be updated throughout the entire application where that task flow is used. Figure 9 is the basic concept of the ADF framework.

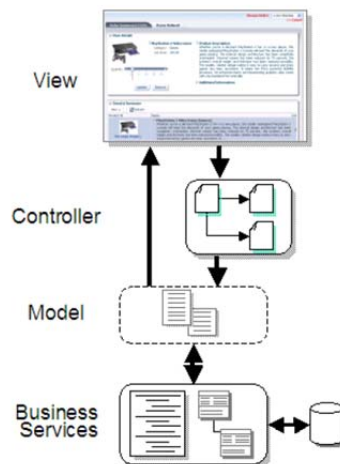


Figure 9. ADF Framework Architecture. Source: Gordon et al (2011).

1. The Business Layer

The user builds this layer by using ADF business components, which are prebuilt and based on best practices for database-centric services (Gordon et al, 2011, p. 55). These components provide the user with the ability to query, update, insert and delete data while maintaining the integrity of the database business rules (Gordon et al, 2011, p. 55). The three main components are entity objects, view objects, and the application module.

a. Entity Objects

Entity objects are used to represent a row in a database table while capturing the business logic to ensure rules established in the database are being followed (Gordon et al, 2011, p. 55). Similar to a database schema, entity objects are associated with one another, which replicates the relationships established between tables in the database (Gordon et al, 2011, p. 55). Once entity objects are built and associations are created, they can be reused in multiple applications that require access to the same data.

b. View Objects

View objects represent a SQL query that can join, filter, sort, and combine data into a view that is required by the end user or the task being accomplished (Gordon et al, 2011, p. 55). View objects use the SQL language and can be pull data from multiple entity objects at once. View objects are then linked to one another with view links in a similar fashion to linking tables in a database. The user has the ability to create complex master-detail hierarchies of view objects using view links to represent information as needed for the end-user (Gordon et al, 2011, p. 56). When an end-user modifies data through the graphical user interface, the view objects work with the entity objects to ensure the information is validated and then saved in the database (Gordon et al, 2011, p. 56).

c. Application Modules

The application module is a transactional element that defines the updatable data model to the user (Gordon et al, 2011, p. 56). The view objects are represented in the

application module and provides the user with the ability to browse and modify data (Gordon et al, 2011, p. 56). Once a user creates view objects, the application module is a great tool to test and validate the functionality of the view objects and corresponding view links before binding them to pages. Figure 10 provides the reader an overview of the three major business components used in the business service layer.

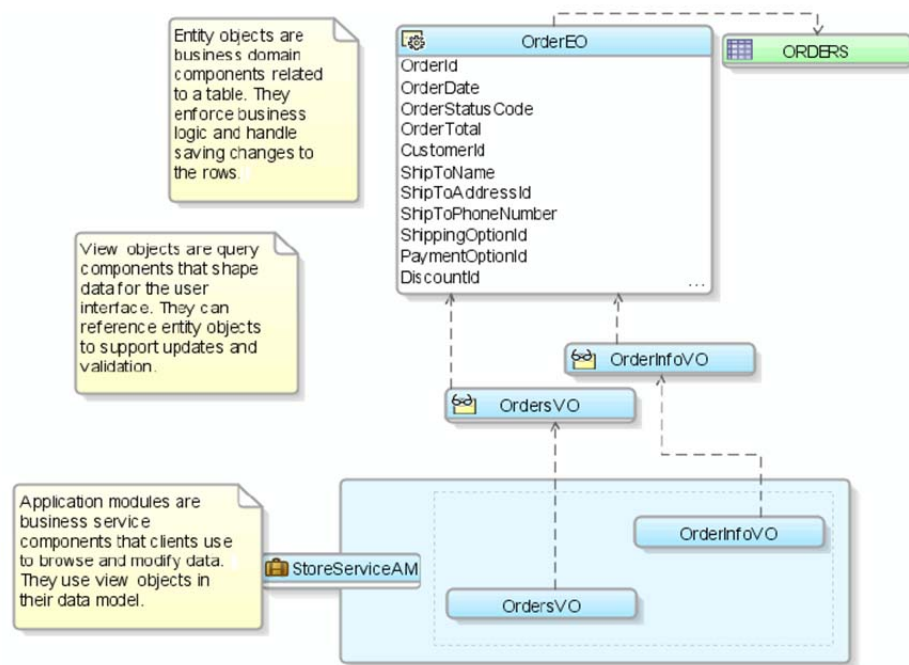


Figure 10. ADF Business Components. Source: Gordon et al (2011).

2. The Model Layer

The model layer connects the business services to the objects as they are used in the other layers by using data controls. Data controls are a Java standard that use the metadata interfaces to abstract the technology of a business service to define the properties, methods and types of data involved (Gordon et al, 2011, p. 57). In JDeveloper, this information is shown as icons that can be dragged and dropped onto a page at which time JDeveloper will automatically create the bindings between the page and the service (Gordon et al, 2011, p. 57). This layer provides a separation from the view layer so that all attributes and actions of a business service are viewed in a consistent way (Ronald, 2011, p. 12).

3. The Controller Layer

The controller layer is a management layer that regulates page navigation and flow. The ADF controller within JDeveloper allows the user to create reusable task flows and page-fragments, which can be used separately or nested within themselves (Gordon et al, 2011, p. 57). Essentially a user can create multiple pages and functionalities on the main page of an application by nesting task flows that contain their own sets of navigable pages (Gordon et al, 2011, p. 57). This feature provides maximum flexibility and reusability for a developer while allowing them to fully control the flow of the application. Figure 11 is an example of a task flow that could be found in an application.

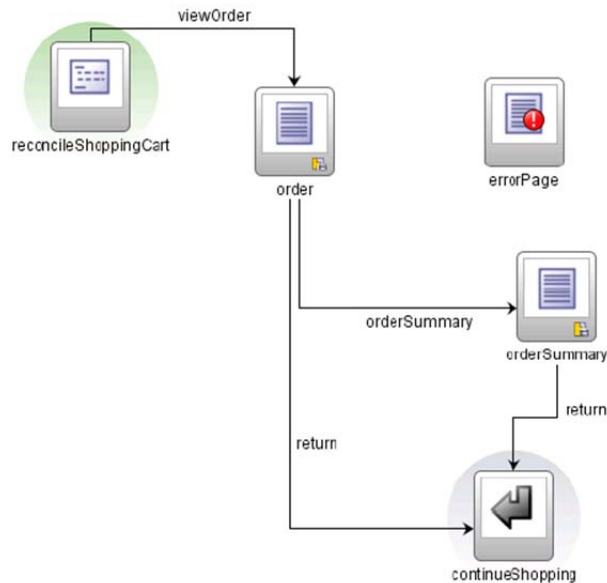


Figure 11. Task Flow. Source: Gordon et al (2011).

4. The View Layer

The View Layer represents the user interface. ADF Faces Rich Client (ADF Faces) is the technology used in the view layer to build browser-based interfaces (Ronald, 2011, p. 15). ADF Faces provides over 100 components that include data tables, tree menus, dividers, tables, and data visualization components such as graphs and gauges (Gordon et al, 2011, p. 58). ADF Faces components have a rendering kit built in which controls the display of the component and the JavaScript that produces the component

(Gordon et al, 2011, p. 58). Having these features built into the drag and drop components allows users to build complex applications without extensive knowledge on how each component operates (Gordon et al, 2011, p. 58).

Oracle JDeveloper and the ADF Framework provides a user with all the technology and standards needed to build a rich application without high-level coding or programming. The simplicity at each layer allows a user to create complex queries, integrated pages and visually appealing applications in a time constrained environment. Figure 12 is the overall architecture of the ADF framework provided by Oracle.

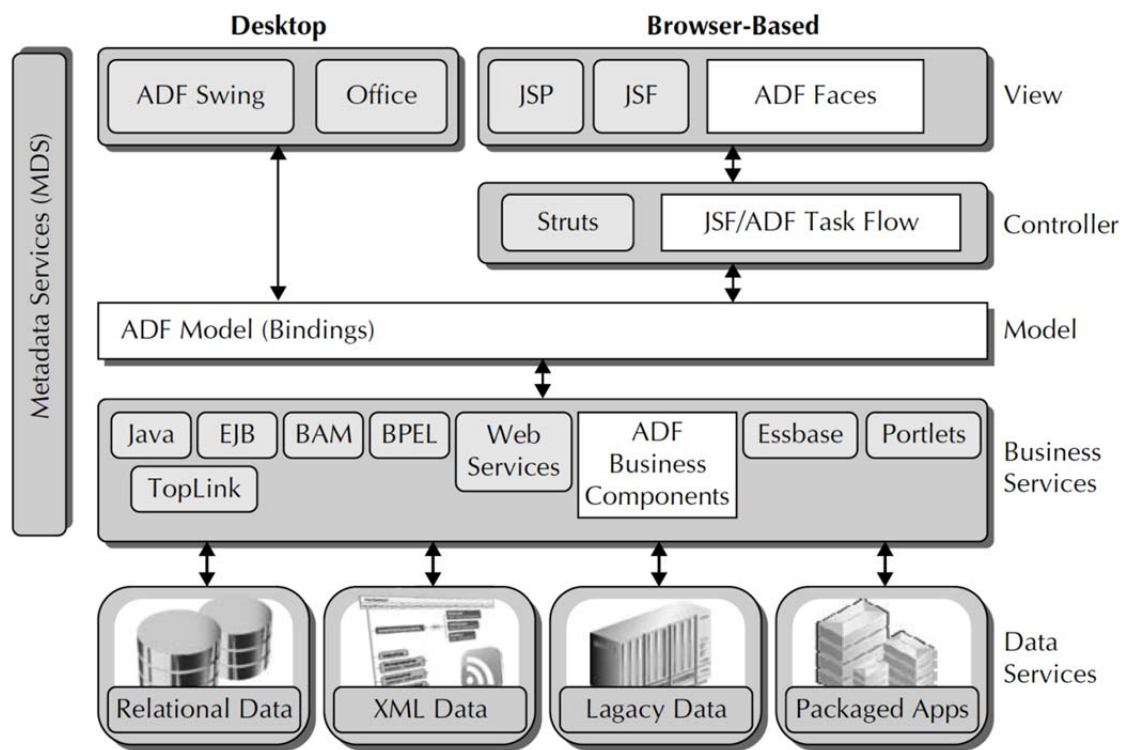


Figure 12. Oracle ADF Architecture. Source: Ronald (2011).

F. WEBLOGIC SERVER

Oracle Weblogic Server is an application server that can be used to control the employment of ADF applications (Gordon et al, 2011, p. 1297). Weblogic server implements all Java EE standard application program interfaces (APIs) which allows for applications to “access databases, messaging services and connections to external

enterprise systems” (Fusion Middleware Understanding Oracle Weblogic Server, 2016, p. 1). Within JDeveloper, a user can deploy an application to the Integrated WebLogic server as a way to test and debug prior to full implementation of the application (Gordon et al, 2011, p. 1296). Weblogic server provides a robust, secure and highly scalable environment for enterprises to deploy mission-critical applications (Oracle, 2016a, p. 1). It also provides diagnostic tools that allow administrators to monitor and alter applications automatically (Oracle, 2016a, p. 1). Lastly, Weblogic server provides expansive security features to protect services and data while preventing malicious attacks (Oracle, 2016a, p. 1). These features are extremely useful to a user because it eliminates the need to purchase or develop their own security functions and management tools. Figure 13 is a depiction of how the Weblogic Server fits into the Fusion Middleware platform.

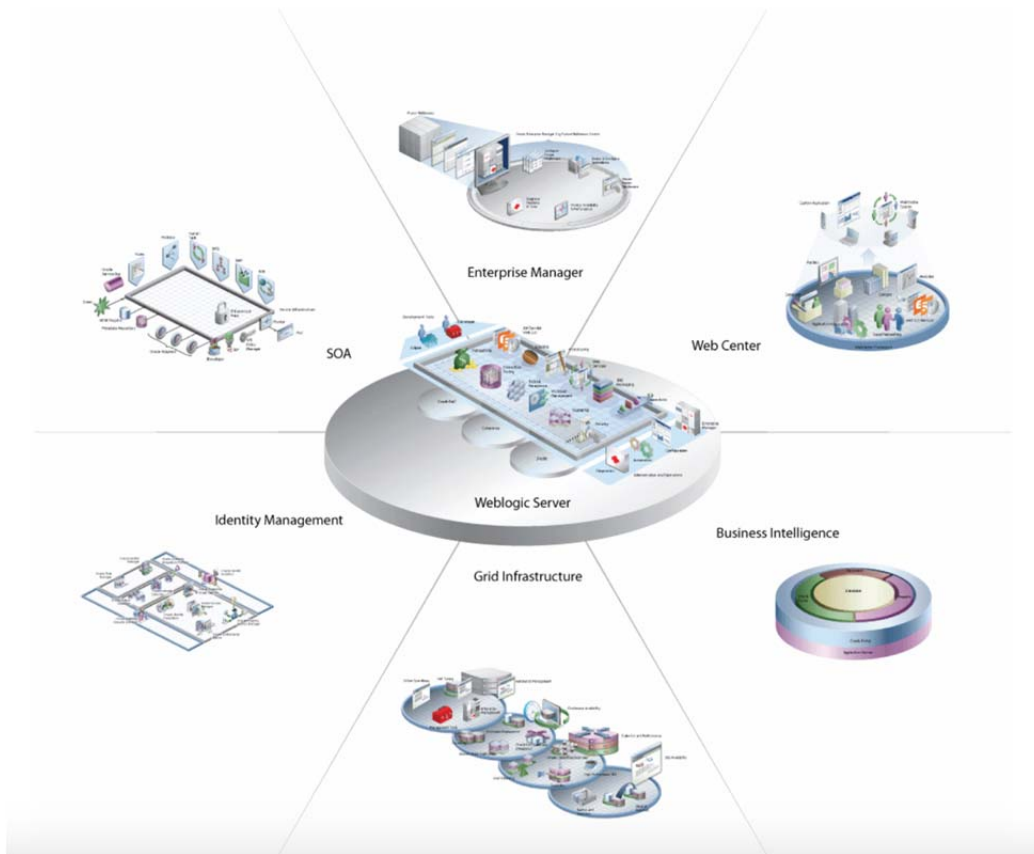


Figure 13. WebLogic Server. Source: Oracle (2016a).

G. SUMMARY

The Oracle brand provides a multitude of products that can be used to successfully and easily develop and deploy applications that support business services. The Fusion Middleware bundles the above mentioned products into one integrated and cohesive unit allowing the user to have control over all aspects of the development process. Each one of these services was used in this thesis when developing the Transportation Capacity Tool. By leveraging Oracle's services, the researchers were able to explore the databases required, conceptualize and develop a functioning application and deploy it through Weblogic server to test its functionality. The development process used by the researchers will be discussed in Chapter V.

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V. USE CASE AND APPLICATION OUTLINE

This chapter describes the application development process used by the researchers. First, the researchers provide background information on how the concept of the application was established, followed by a description of the scenario used as a use case. Next, the researchers explain the development process and how the Oracle services discussed in Chapter IV were utilized to build the application. Following this explanation is a depiction of the proof of principle web application to include design and functionalities of each page. Lastly, the researchers discuss possible future iterations for this application.

A. INTRODUCTION

Through research and discussions with the Marine Corps' sponsors, the researchers developed the idea of an application that combined information from multiple databases onto one platform. After examining numerous logistical related databases, the researchers chose to utilize TCPT and TBMCS to produce the analytics necessary for the proof of principle application. TCPT is a web-based application used to plan, manage, and execute ground transportation and engineering missions (DON, 2012). TBMCS is a command and control system comprised of eight separate schemas that is used across all services to securely plan and manage the execution of air missions (Collens & Krause, 2005, p. 5).

This application is intended to combine transportation asset usage from both aviation and ground units. There are two main objectives for this application. First, the application captures mission data related to both air and ground missions to provide a snapshot of missions executed by each unit on different dates. This provides the commander with the background information on the missions to reduce the need to toggle between other systems. The second objective is to analyze the performance of the mission by calculating the usage rate for each individual asset. Mission data, to include the usage rate, for air and ground missions are not usually available in one location as the air missions are tracked by the operations section and the ground missions are tracked by the

logistics section. When the air and ground logistical support mission and analysis is combined into one view, the commander is able to analyze the performance of all transportation assets, not just one platform.

B. USE CASE

The Marine Corps sponsors provided the scenario used as a use case for this application. It is based on a Marine expeditionary brigade (MEB) scenario in which two separate MEU's are tasked with conducting air and ground support operations for troops located at different locations. The two MEU's are located at separate sea bases and troops operate from separate landing zones (LZ). In this scenario, the MEB commander has control over the 11th and 24th MEUs as they conduct sustainment operations. The application provides the MEB commander with the appropriate information for air and ground missions that were conducted by all units that are subordinate to both MEUs. This gives the MEB commander better situational awareness on how to maneuver and task the subordinate units to more effectively conduct logistical support missions. Figure 14 is a depiction of the scenario.

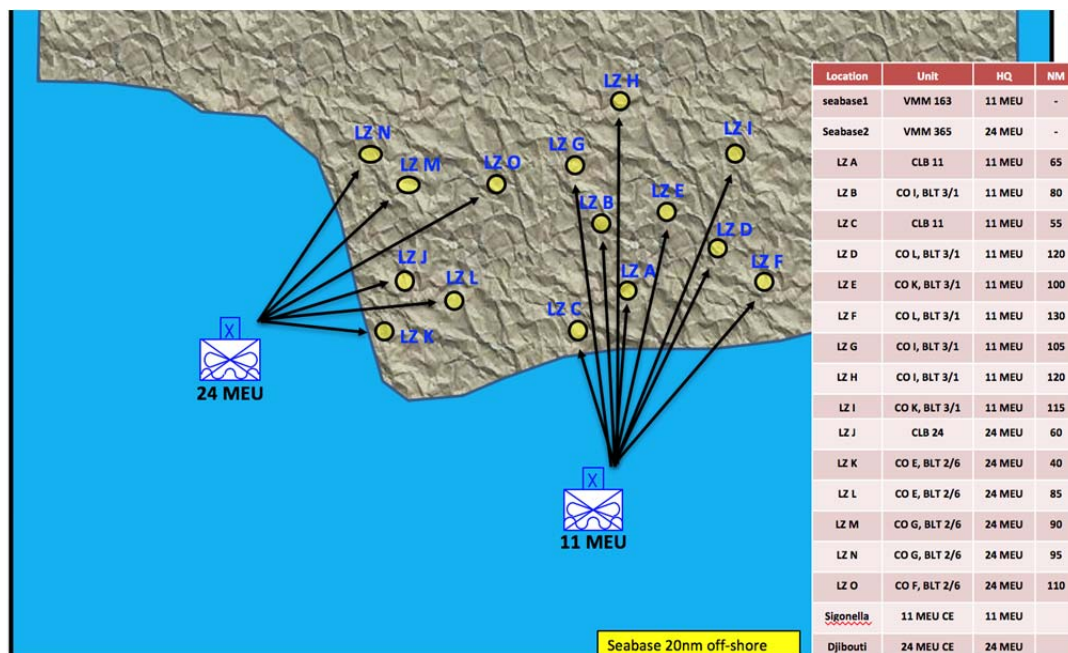


Figure 14. MEB Scenario. Adapted from: Marine Corps Sponsors and Capt Snyder (2016).

C. APPLICATION DEVELOPMENT PROCESS

This section describes the Oracle products used to build the application. This section also discusses the process used to extract and load the data, the revision of ER diagrams from the databases and the application page layout.

1. Products Utilized

The researchers leveraged the Oracle products discussed in Chapter IV. SQL Developer was used to capture, view, and analyze the databases and corresponding data. This allowed the researchers to modify any “dirty data,” capture table relations, and determine which tables and attributes would be needed for the application. The researchers then used JDeveloper, along with the ADF framework, to design and develop the application. Lastly, the application was deployed in the Weblogic Server environment in order to test its functionality. All of these services are encompassed within the Oracle Fusion Middleware architecture.

2. Database Extraction/Insertion

The researchers received SQL scripts for the TCPT and TBMCS databases, which included all tables, primary and foreign keys, constraints, and data. These scripts were inserted into SQL Developer in order to view and manipulate the information. The TCPT scripts provided a robust collection of data from over 3000 units across the Marine Corps. The TBMCS scripts, however, did not include any mission related information. This is likely due to the fact that this system is deployed on a secure network. The researchers developed over 900 lines of data that created 150 complete air missions in order to supplement the insufficient data from the TBMCS scripts. The data created was relevant to scenario described above.

One of the main intentions of this application was to ensure redundant work was not required by the end-user. For example, the current structure would require an end-user to extract data from TCPT and TBMCS separately and then compile into one report to analyze. It is important to the development of this application that when this application pulls information from the two systems, the end-user does not have to do any

additional work. Therefore, in an effort to utilize the existing data sets as much as possible, additional tables or attributes were not added to the schemas.

3. Reviewing Schemas and Data

First, all tables and data were inserted into the researcher's Oracle database instance via SQL Developer. Second, the researchers reviewed the data to determine which tables and, more specifically, which attributes were needed to produce the required analytics. SQL Developer was used to reengineer entity relationship (ER) model diagrams in order to have a visual model of how all tables are related to each other in the database. The ER diagrams for the tables used from TCPT and TBMCS are shown in Figures 15 and 16.

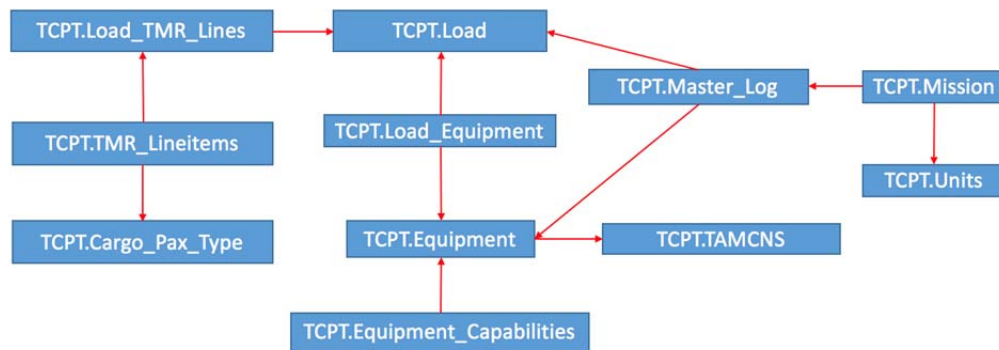


Figure 15. ER Diagram for TCPT

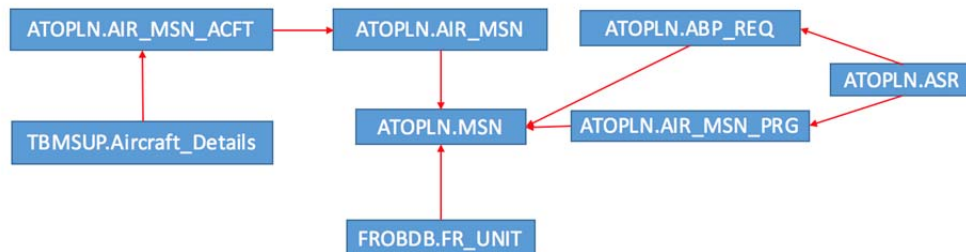


Figure 16. ER Diagram for TBMCS

4. Designing the Application

After determining which information was required from the schemas, the researchers developed a mock story board of how the application would function. This was used to brief the sponsors and receive feedback on how the application should be designed. Once agreed upon, the layout of pages was developed in JDeveloper using the task flow manager. Figure 17 is the final task flow of pages used in the application.

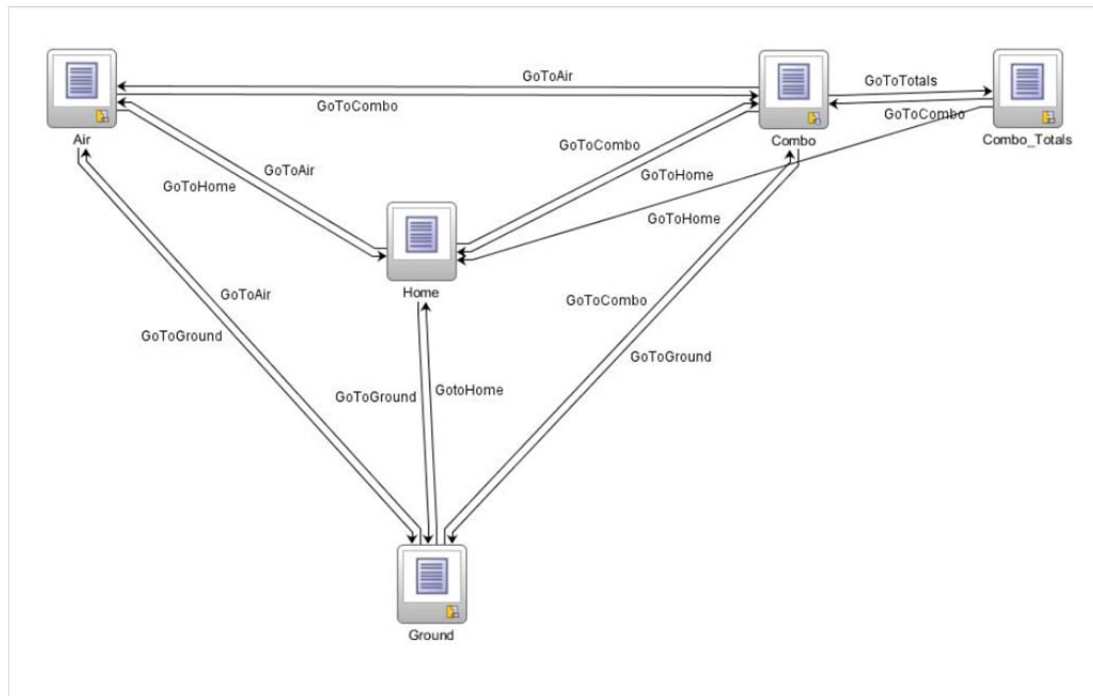


Figure 17. Transportation Capacity Tool Application Task Flow.

The application consists of five pages: 1) Home, 2) Air, 3) Ground, 4) Combo and 5) Combo Totals. Each page is described in more detail in this chapter. When designing the application in JDeveloper, the researchers ensured the user interface was simple to use and provided graphics that could be easily interpreted and presented to a commander. The researchers developed the application using the visual method in JDeveloper almost exclusively, without manually changing any code. In doing so, this application could easily be recreated. A full list of setup instructions can be found in Appendix D.

D. PAGE DESIGNS/FUNCTIONALITIES

The application has three main segments, which include an air, ground and combo. All three segments can be accessed from the home page and through links on each subsequent page. The following sections describe each page layout and the functionalities within the application.

1. Home Page

The home page is a generic page that provides access to each of the different pages through use of navigation buttons. These buttons also exist on all other pages to allow the end-user to navigate between each platform quickly without the need to return to the homepage. Figure 18 is the design of the home page.



Figure 18. Transportation Capacity Tool Application Home Page.

2. Air Page

The end-user can navigate to the air page by clicking on the “Air” button located on the home page. Once at the Air page, the end-user is able to navigate through all air units using the navigation panel under the “Unit” section. Once a unit is selected, the end-user can then navigate to different mission dates under the “Date” section. When navigating, the end-user sees all missions completed on that particular date under the “Mission” section. Figure 19 is a screenshot of an air mission conducted on January 1, 2015.



Transportation

Unit
Unit VMM365
Location Seabase1
First Previous Next Last

Mission

Mission Id	ABP ID	ASR #	Mission Category	Mission Usage	Usage Meter
000000000000009	ThesisDummyData	0009	HLOG	100%	

Date
Mission Date: 2015-01-05
First1 Previous1 Next1 Last1

Mission Details
Unit Supported: CLB 24
AsrReqId: 0009
Takeoff Location: Seabase 2
Landing Location: LZ J
A/C Type: MV22
A/C Qty: 1
External Cargo Weight (lbs): 0
Internal Cargo Weight (lbs): 900
Pax: 23
Internal Usage: 4%
External Usage: 0%
Pax Usage: 96%
Total Usage: 100%

Ground Combo Home

Figure 19. Transportation Capacity Tool Application Air Page.

The Mission section provides the end-user with the mission identification (ID) number, the air battle plan (ABP) identification, assault support request (ASR) number, and the mission category. The section also provides a transient attribute that calculates the total mission usage rate and represents the rate with the usage meter. The “Mission Details” section provides the end-user with more information that is derived from the ASR, which includes the unit supported, takeoff and landing locations, aircraft type, and quantity. The section also takes information about each aircraft type located in the database and calculates the total usage based on the capabilities of the aircraft. In the example shown above, the ASR requested to move 900 pounds of cargo internally and 23 passengers. Based on known aircraft capacity data located in the database, the transient

attribute calculated the internal cargo capacity at 4% used and 96% of the passenger capacity used. Thus, in this example, the mission resulted in a 100% usage rate.

While this application provides raw data and calculations, there are often situations in which the numbers do not properly reflect the objective of the mission. In some cases, the end-users will have to revert back to the actual ASR and mission data to interpret the results. This could include missions that involve hazardous material, specific ammunition or medical evacuation types of missions. In those cases, the analytic results may show low usage rates and will need further interpretation provided to the commander.

3. Ground Page

The ground page is designed in a similar fashion to the air page. Figure 20 is a screenshot of a mission conducted on January 8, 2015.

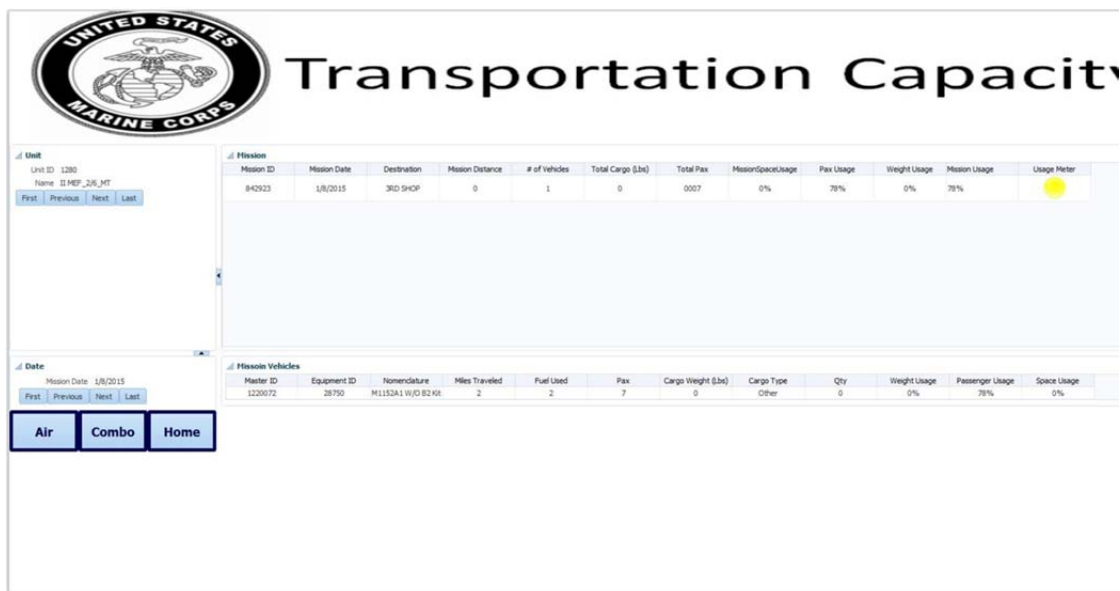


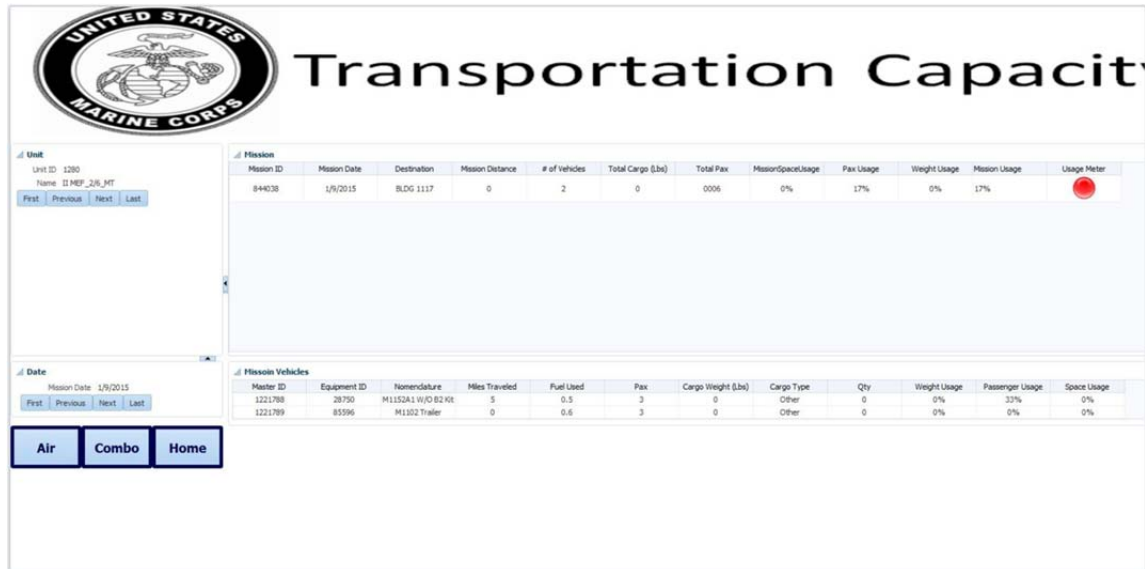
Figure 20. Transportation Capacity Tool Application Ground Page.

The end-user would navigate through units and mission dates the same way as the air page. The “Mission” section provides the end-user with the mission ID, destination,

mission distance (miles), number of vehicles and the total usage rate for the entire mission. Ground transportation usage can be depicted in two different ways, by weight and by space. Each vehicle type has a weight capacity and a space capacity. Depending on what information is recorded in TCPT, the mission usage rate can vary.

The “Mission vehicle” section provides information for each vehicle used in the mission to include Master ID, Equipment ID and nomenclature, and detailed information about the cargo transported. Each individual vehicle’s usage rate is calculated and are combined to generate the total mission usage, which is visible in the “mission” section. Similar to the air page, there is information within the database about each vehicle type. Each vehicle type has the ability to transport different cargo types. For example, a 7-ton truck can move one International Organization for Standardization (ISO) container, four quadruple containers (QUADCONs), or 16 warehouse pallets. Therefore, the database must provide the capabilities of each vehicle for each cargo type. The application will then calculate the usage rate based on the capacity of the vehicle and the cargo transported.

As seen in the example from Figure 20, the cargo type is “other”. The selection of “other” in the cargo type was an issue seen throughout many entries in TCPT. There are options for nearly all types of cargo being transported, yet “other” was selected for multiple entries. The cargo type should identify whether the cargo is an ISO container, pallet, six container (SIXCON), QUADCON, passengers, etc. When “other” is recorded in the system by the TCPT end-user, the application cannot determine the space capacity. In this case, the application will only calculate the usage rates based on passengers and weight, if those fields were entered. Using the “other” cargo type is an example of dirty data and can lead to a misinterpretation of data. For example, if a 7-ton is transporting an empty ISO container, the weight usage rate may reflect poorly because it will be significantly less than a 7-ton’s weight capacity. However, a 7-ton can only transport one ISO container at a time therefore would reach its space capacity. If the cargo type was selected as “other” than the space usage rate could not be calculated. Dirty data is discussed in Chapter V.



This figure is a mission that includes more than one vehicle.

Figure 21. Transportation Capacity Tool Application Ground Page

As a reminder, there are often times when further interpretation is required to gain a deeper understanding of the mission. As noted earlier, when the numbers do not properly reflect the objective of the mission, the commander must then determine if the cargo or passengers selected is accurate, if the cargo type is accurately selected in the database, or if there is another reason for the disconnection between the data and the mission. The end-user can revert back to TCPT in order to get more detailed information on certain missions to provide a clearer analysis.

4. Combo Page

The Combo page combines information from both the air and ground platforms to provide a combined view of both types of mission information. Figure 22 is the Combo page. The end-user will choose a unit by using the navigation buttons. The unit selected provides information for missions conducted by all subordinate units. In this example, the 24th MEU was selected and all missions conducted by their subordinate air and ground units are displayed.



Figure 22. Transportation Capacity Tool Application Combo Page.

This page includes the unit, mission date, mission numbers and the usage rate for each mission. Also displayed are the total air missions, ground missions and average usage rates for each platform. This information is valuable to a commander because he or she can see how each platform is utilized during a specific timeframe. To get a more detailed view on usage rates, the end-user can select the “combo totals” button to see a graphical display of usage rates. Figure 23 is the totals page.

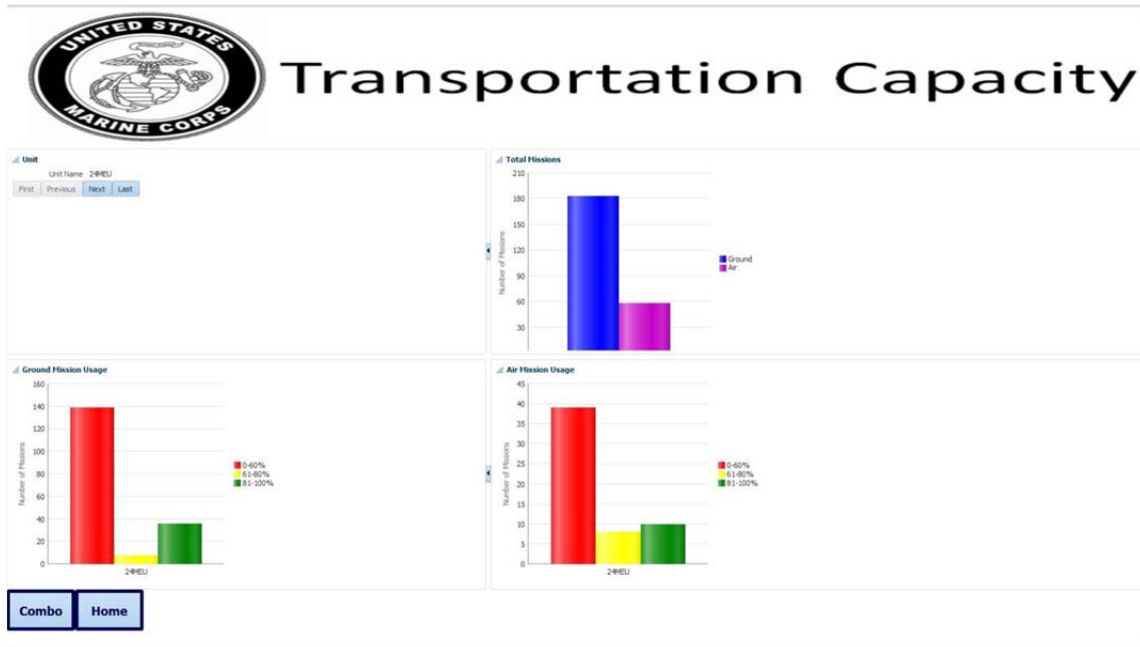


Figure 23. Transportation Capacity Tool Application Combo Totals Page

The “total missions” graph depicts the air and ground missions conducted by the unit. The “ground mission usage” graph is the total number of missions that fall into each usage rate category. For this research, the researchers depicted red as 0–60% usage, yellow as 61–80% usage, and green as 81–100% usage. The “air mission usage” graph depicts the total number of missions that fall into each usage rate category as well. These graphs give the commander a quick synopsis of how each platform is performing in terms of usage. This example shows that on both the air and ground side, the majority of missions are being underutilized at below 60%. As mentioned above, some missions may need further interpretation in order to provide an accurate evaluation.

E. FUTURE ITERATIONS

This application shows a commander, in one place, how his or her aviation and ground assets are being utilized. Logisticians may also benefit from this application in determining future support. This application was built as a proof of principle to demonstrate how integrating data from multiple databases into one dashboard can provide a well-rounded and more complete view of a unit’s assets. In developing this

application, the researchers did not add in any additional functionality or cosmetic features but provide recommendations on improvements for future iterations.

First, a more user-friendly search tool to select the unit and date could be added to reduce search time. Also, different graphics could be used to represent the analytics that are more appealing to those briefing commanders. Lastly, more information can be pulled from TCPT and TBMCS to represent other aspects of transportation capacity. More specifically, a feature could be added to show how many assets (air or ground) were available on a particular day and how many were being used for missions. The end-user would not only see the capacity of each asset used, but also the total capacity of their fleet being used. An end-user could then easily calculate a ratio and develop trends lines to identify potential improvements in efficiencies.

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VI. CONCLUSION

This chapter summarizes the author's research including an analysis of organizational design and Log IT systems using a systems approach exemplified by a proof of principle model. Second, the researchers answer the primary research questions posed in Chapter I from the methodology used for this thesis. Third, there are several lessons learned through the course of this research that will benefit future development of transportation analytics at the tactical level of operations and successive Log IT system requirements. This chapter also includes recommendations based on the lessons learned. Lastly, this chapter recommends future research opportunities for the Marine Corps.

This chapter is organized in four separate sections: Section A summarizes this thesis, Section B answers the primary research questions, Section C covers lessons learned and recommendations, and Section D proposes future research opportunities.

A. SUMMARY

This thesis explored the validity of applying a systems approach to the MAGTF in order to increase Marine logistician's decision-making and meet the principles set forth in EF21. These principles include: 1) support an expeditionary mindset and 2) maximize organic capabilities/limit contracting (HQMC, 2014a, p. 41). Guided by these principles, the researchers accomplished an in depth review and discovered that not only were Log IT systems critical in facilitating these goals, but the management and use of these systems was also essential in providing MAGTF commanders the necessary information for increased situational awareness and enhanced decision making.

The researchers discovered that it is imperative that the appropriate organizational design is applied to the three different levels of the Marine Corps because it directly influences how successful each level will be at implementing and executing policy. At the strategic and operational level, logistics modernization policies need to be standardized in accordance with a mechanistic design using a centralized approach. This standardization will increase the vertical information flow throughout the Marine Corps, which is enhanced by properly using Log IT systems to support strategic goals. At the

tactical level, units are executing the strategic goals and providing feedback in accordance with an organic design using a decentralized approach. Horizontal communication is enhanced across the MAGTF when the Log IT systems are established to support communication and control for the MAGTF CE, LCE, ACE and GCE.

For instance, the researchers discovered that loose guidance and direction concerning Log IT policy documents at the strategic level give units at the tactical level the ability to create their own operating procedures and choose which Log IT system they want to employ to track logistics. While commander's discretion is encouraged at the tactical level, it should not apply to Log IT systems. Instead, commander's discretion should be used to influence the information requirements generated by the Log IT system. Unfortunately, current practices in using Log IT systems impede vertical and horizontal information flow because each unit has the ability to dictate which Log IT systems they want to use and there is a copious amount of options available. This practice creates a gap in logistics performance metrics across the Marine Corps.

The researchers applied an organic design model to the MAGTF and discovered that using this model, horizontal information flow between the LCE, GCE and ACE could be increased in support of logistics operations. Increasing both vertical and horizontal information flow with accurate information directly correlates into increased efficiency and effectiveness. This thesis demonstrated the validity of applying the organic design model to the MAGTF by specifically addressing both air and ground transportation assets at the MEU.

The researchers created a proof of principle model in order to demonstrate how well a MEU commander's situational awareness could be improved with a soundly designed application. For this thesis, the proof of principle model was a transportation dashboard that pulled information from IT systems already in use by the ACE and LCE in order to show that the MAGTF CE could consolidate this information and make better recommendations and analysis on how effectively the MAGTF employs transportation assets in support of operations. The researchers envision that the MAGTF CE S-4 would benefit most from using this transportation dashboard as he or she is the senior logistician

within the MAGTF CE with the ability to impact logistics operations throughout the MEU.

B. RESEARCH QUESTIONS

1. What is the current organization of the MAGTF as it relates to Log IT systems to include for example, roles, users, and functionality?

For this particular thesis, we limited the question to only address the Marine Expeditionary Unit (MEU) using IT systems for both air and ground transportation. The researchers discovered that there is no standard for units to use Log IT systems, which created a gap in the MAGTF commander's situational awareness. For instance, according to current policy, units could use either TCPT or CLC2S with GCSS-MC for requesting and tracking ground transportation. For air transportation, the ACE uses TBMCS. Consolidating relevant logistics information, the researchers recommend that the MAGTF CE S-4 is the most appropriate agent to interpret transportation analytics and provide recommendations to the MAGTF commander for more efficiently and effectively using transportation assets.

2. How well can this application design use and access existing logistics databases?

In using Oracle products, there will be limited issues when accessing existing databases. Once the tables are loaded into the application using SQL scripts through SQL Developer, the application can easily be updated with current data. As stated previously, there were only minor modifications made to the structure of the data and those were done within the model layer of the application. Therefore, updated data extracted from TCPT or TBMCS will not need to be structurally modified before importing it into the application. The major obstacle foreseen is that when deployed, both databases are located on a secure network. The application must be built on a secure network in order to maintain the integrity of the data's classification. Further research should be conducted to determine the appropriate frequency in which data should be extracted and loaded into the application in order to ensure it is timely and useful to the commander. An additional consideration is that the closer the data is to near real time, the extraction process will be

more expensive. Therefore, a cost-benefit analysis should be conducted to determine what is appropriate and effective for this application.

3. Through analytics, how can we use information from command and control (C2) and in-transit visibility (ITV) databases to effectively employ air and ground distribution of supplies to support the MAGTF?

The researchers built a proof of principle transportation dashboard that could be used by MAGTF commanders to enhance decision making by automating usage metrics. For example, the transportation dashboard provided analytics that show the usage rate for each mission as well as each asset on that mission. For aviation, the usage rate was determined by weight and passenger restrictions for each aircraft type. For ground transportation, it was determined by space, weight and passenger restrictions. These metrics depict how efficiently and effectively units are employing their assets for logistical support missions. The application provides information related to each mission as well as combines both air and ground onto a single page. No other system in the Marine Corps inventory does this. A commander can make better decisions on how to use his or her assets for logistical missions by combining air and ground usage into one page.

C. LESSONS LEARNED AND RECOMMENDATIONS

This section summarizes the lessons learned during this thesis development that will benefit future researchers in this area. This section also provides recommendations based on observations throughout the course of this study.

Lessons learned are:

- Veracity of data is an issue and negatively impacted the quality of the transportation analytics the researchers performed.
- Bandwidth directly affects how effectively Marine logisticians are able to use IT systems in a deployed environment.
- Policy documents that are not standardized and enforced through formal reports will decrease the likelihood that they are successfully implemented across the organization.
- Multiple Log IT systems are not effective in capturing the appropriate information requirements needed for a MAGTF commander to make the most informed decision.

- The lack of feedback mechanisms within the MAGTF will perpetuate recurring issues, retard implementation of policies and decrease learning in the organization. For instance, if the Marine Corps uses a feedback mechanism supported by Log IT systems then strategic goals can be better assessed. Once positive change occurs at the tactical level, the Marine Corps can successfully implement these changes through the strategic and operational levels in a centralized fashion, which in turn promotes learning and improvement supported by Log IT systems.

Recommendations are:

- Enforce quality of data entry by creating drop down boxes for Log IT systems vice allowing Marines to type entries. Some Log IT systems give users the capability to type entries, which increases human error and reduces the accuracy of reports generated by the Log IT system.
- Capture the current logistics operational architecture from MCBUL 4081 using a systematic approach and create phased plan to reduce the amount of systems Marine logisticians use to support operations.
- Reduce amount of Log IT systems and focus funding. The logistics operational architecture will be improved and easier to maintain by reducing the amount of Log IT systems. Also, the Marine Corps can use funds saved from reducing multiple systems to further develop GCSS-MC into a better tool for Marine logisticians.
- GCSS-MC is an enterprise system and needs to be the backbone of the logistics operational architecture. Based on GCSS-MC, future Log IT systems need to be Oracle based and have the ability to interact with the system. Also, facilitate operational security by migrating GCSS-MC to operate on SIPR while deployed.
- Facilitate Joint Log IT systems. The benefit of using GCSS-MC is that not only is it an enterprise system, but it also can be used in conjunction with GCSS-Army. This is essential in joint logistics environments for support and needs to be a metric for funding future Log IT systems.
- Improve deployed support and training. Marines are deterred from using Log IT systems while deployed when the Log IT system does not work either due to bandwidth or compatibility issues beyond the users training or experience. Successfully supporting GCSS-MC in a deployed environment is contingent on deployed support team and amount of bandwidth reserved for the system.
- Automate Log IT Systems. Reduce human error by automating the information captured by Log IT systems. This type of Log IT system will support both anticipatory and responsive or hybrid method of support to

provide Marine logisticians greater flexibility with more accurate information.

- Create a logistics command and control (C2) operational advisory group (OAG) with the mandate of accomplishing the following tasks: 1) Develop strategic goals, 2) Develop formal reports generated by the Log IT system that will be used to support strategic goals, 3) Establish metrics of performance/effectiveness and 4) Develop standardized processes on how the Log IT system should be used within the organization, 5) Formalize positive change through updated policies.
- Designate specific military occupational specialists (MOS) to use Log IT Systems. For instance, within the MAGTF CE S-4, an MOS 0491 Logistics/Mobility Chief is most appropriate because they work in collaboration with the MAGTF CE S-4 Officer and are trained to plan, coordinate and supervise a variety of logistical functions in support of operations. Furthermore, these Marines provide valuable first hand expertise on improving information requirements generated by the Log IT system because they typically come from either the MOS 0431 Logistics/Embarkation Specialists or MOS 0481 Landing Support Specialists.
- Improve formalized training to increase better decision making and standardize logistics operations across the MAGTF. MOS 0491 Logistics/Mobility Chief could be sent to formal schools as provided by the Army Logistics University (ALU) or the Marine Corps Combat Service Support School (MCCSSS) to encourage building personal relationships across the community and serve as a venue to update policies in a school environment as well as increase learning from shared experience.
- Adopt standard business processes and encourage learning across the organization. One issue with supporting multiple Log IT systems that provide redundant capabilities is that it creates an environment where each MEF is allowed to employ Log IT systems according to their unique preferences of doing business. For instance, each MEF has their own unique operating procedures that dictate which Log IT systems are used in support of operations. Unfortunately, each MEF operates differently and may prefer one Log IT system over another which trickles into the tactical units. As a result, individual Marines moving from I MEF to II MEF or III MEF will be required to learn different methods of accomplishing similar tasks. This practice decreases efficiency and effectiveness, as individual Marines will need time to adapt to new environments. By standardizing Log IT systems across the organization, Marines will more easily adapt to new environments and will more effectively accomplish tasks while supporting complex, dynamic operations.

- Enforce the appropriate level of expertise is using the application and interpreting the results. While having a Log IT system generate a formalized report is convenient for the commander, it may not be beneficial if the end user does not understand the data contained within the reports. For example, hazardous materials may restrict an aircraft's ability to maximize its cargo utilization. This low utilization metric should not adversely impact the aircraft. It is imperative that the appropriate level of expertise provide the commander with this kind of granularity when briefing metrics that are indicative of performance.
- Recognize and implement current data trends. As the Marine Corps collects more logistical data, the organization should leverage this data and apply the principles of big data analytics while also balancing the related challenges of big data such as volume, variety, veracity, and velocity in order to provide the best analytics and metrics on their performance. Applying these principles will give Marine logisticians the granularity to make the most informed decision when making a recommendation to the MAGTF commander on how to use his or her transportation assets.
- Replacing obsolete and outdated systems. As the Marine Corps funds new IT systems or removes IT systems from their inventory, the application developed in this thesis can still be applied with minimal changes. The Model-View-Controller framework implemented by ADF allows for the data-model to be updated without needing to rebuild the view and controller layer. The metrics may change based on the data provided by the new IT system, but the overall function of the application will remain. Also, new analytics from the same data sources can be developed rapidly to meet new tactical challenges. This feature would be extremely useful in the case of either TCPT or TBMCS becoming obsolete.

D. FUTURE AREAS OF RESEARCH

Currently, the DOD employs contractors to build, maintain, and work databases and applications that are used to support decision-making within the logistics and supply fields. These projects typically have ill-defined requirements resulting in projects that are over budget and behind schedule because of the lack of DOD expertise in these unique fields. In order to be more efficient and build a better application to meet user requirements, the DOD could train individuals in rapid application development using Oracle-based software. DOD trained users could develop these applications to meet specific needs of a commander or a unique mission set. Additionally, these applications

could pull information from current deployed databases in order to provide useful analytics and reports. The ability to rapidly develop and modify an application without being restricted by a contract is extremely beneficial because the DOD operates in a dynamic environment. A potential future project could be to conduct a cost-benefit analysis on using contractors to develop applications versus sending individuals through Oracle-based training to develop their own applications. A mock application could be built as a proof-of-concept to support the idea of using internal personnel to build applications that meet the unique mission requirements that are set by the MAGTF commander.

APPENDIX A. DEPLOYED MDDOC STRUCTURE TEMPLATE

MCO 4470.1A
03 NOV 2014

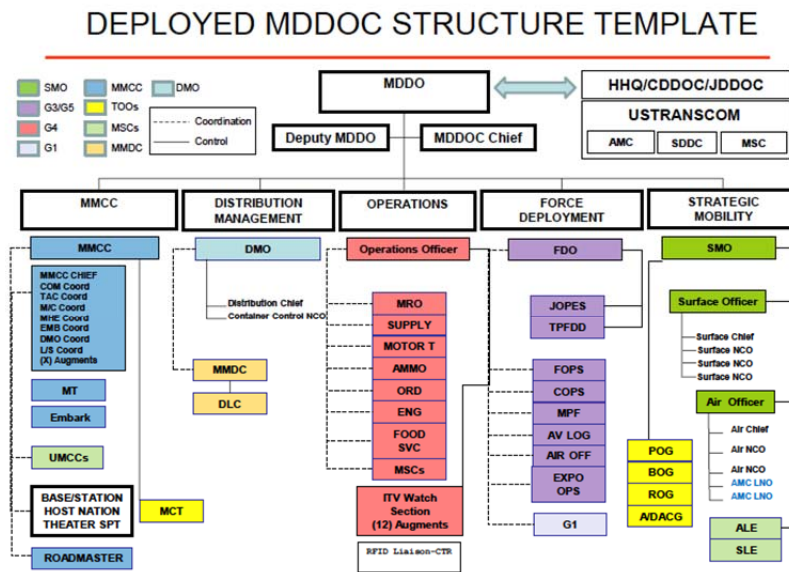


FIGURE 2.--MDDOC STRUCTURE - DEPLOYED

(Recommended structure, only. Actual structure is at the discretion of the MEF Commander.)

Figure 24. Deployed MDDOC Structure. Source: Department Of Navy (2014).

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APPENDIX B.

This appendix lists the schemas, tables and attributes from both TCPT and TBMCS that are used to build the view objects. This list would be used in the extraction, transform and load (ETL) process.

A. TCPT DATABASE

1. TCPT Schema

a. Table: Units

- Attributes:

ID
Name
Short_Name
Parent_ID
Location_ID

b. Table: Mission

- Attributes:

ID
Organization_ID
Arrival_Time
Destination
Mission_Distance

c. Table: MasterLog

- Attributes:

Master_ID
Mission_ID
Equipment_ID
Fuel_Used
Load_ID
Miles_Traveled
Passengers
Cargo_Weight

d. Table: Load

- Attributes:

Load_ID
Mission_ID

e. Table: LoadEquipment

- Attributes:

Equipment_ID
Load_ID

f. Table: LoadTMRLines

- Attributes:

Load_ID
TMR_Line_Item_ID
Qty

g. Table: TMR_Lines_Items

- Attributes:

ID
Cargo_ID

h. Table: Cargo_Pax_Type

- Attributes:

ID
Description

i. Table: Equipment_Capabilities

- Attributes:

Equipment_ID
FOURSIXTHREELON
FUELON
ISOON
PALCON_ON
PAXON
QUADCONON
SIXCONON

STDPALLETON
TEU_ON
TOTALSTON
WATERBULKON

j. Table: Equipment

- Attributes:

Equipment_ID
TAMCN_ID

k. Table: TAMCNS

- Attributes:

ID
NOMENCLATURE

B. TBMCS DATABASE

1. ATOPLN Schema

a. Table: MSN

- Attributes:

Tasked_FR_UNIT_ID
MSN_WW_ID
ABP_WW_ID

b. Table: Abp_Req

- Attributes:

ABP_REQ_NLT_DTTM
ABP_WW_ID
ABP_REQ_ID
MSN_CAT_CD

c. Table: ASR_MSN_PRG

- Attributes:

ASR_REQ_ID
ABP_WW_ID
ABP_REQ_ID
MSN_WW_ID

ASR_MSN_PRG_ID
AMO_ID

d. Table: Air_MSN

- Attributes:

Air_MSN_Takeoff_Loc_NM
MSN_WW_ID
Air_MSN_Landing_Loc_NM

e. Table: Air_MSN_ACFT

- Attributes:

ACFT_MDS_TYPE_CD
MSN_WW_ID
Air_MSN_ACFT_Group_ID
Air_MSN_ACFT_Aircraft_QTY

f. Table: ASR

- Attributes:

ASR_PYLD_EXTR_Cargo_WT
ABP_WW_ID
ABP_REQ_ID
ASR_REQ_ID
ASR_PYLD_INT_Cargo_WT
ASR_PYLD_Troop_TX
ASR_PYLD_Type_CD

2. FROBDB Schema

a. Table: FRUnit

- Attributes:

Unit_ID
Unit_CTRY_CD
Unit_Parent_ID
Unit_Parent_CTRY_CD
LOC_NM

3. TMBSUP Schema

a. *Table: Aircraft_Details*

- Attributes:

Aircraft_Model_Code
Cargo_Capacity
Passenger_Capacity
SCL

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APPENDIX C.

This appendix provides the SQL scripts used to build the View Objects for each page within the application; the transient attributes that were developed; the view links that connect each view object; and the data model for each application module.

A. AIR PAGE

1. View Objects:

a. *Air_Unit_InfoVO*

```
SELECT FrUnit_EO.FR_UNIT_ID, FrUnit_EO.FR_UNIT_CTRY_CD,  
FrUnit_EO.FR_UNIT_PARENT_ID,FrUnit_EO.FR_UNIT_PARENT_CTRY_CD  
, FrUnit_EO.LOC_NM FROM COMBINED_SCHEMA.FROBDB FR_UNIT  
FrUnit_EO WHERE Frunit_EO.Fr_Unit_ID = '24MEU') OR  
(Frunit_EO.Fr_Unit_ID = '11MEU') OR (Frunit_EO.Fr_Unit_ID =  
'24 MEU CE') OR (Frunit_EO.Fr_Unit_ID = '11 MEU CE') OR  
(Frunit_EO.Fr_Unit_ID = 'VMM163') OR (Frunit_EO.Fr_Unit_ID =  
'VMM365')
```

This view object has a 'where' clause so that it will only pull data for the units that fall under the 24th and 11th MEUs. This allows the user to customize the data that they will be viewing.

b. *Air_Unit_DateVO*

```
SELECT Msn_EO.TASKED_FR_UNIT_ID, Msn_EO.MSN_WW_ID,  
AbpReq_EO.ABP_REQ_NLT_DTTM, AbpReq_EO.ABP_WW_ID,  
AbpReq_EO.ABP_REQ_ID FROM COMBINED_SCHEMA.ATOPLN_MSN  
Msn_EO, COMBINED_SCHEMA.ATOPLN_ABP_REQ AbpReq_EO WHERE  
(Msn_EO.MSN_WW_ID = AbpReq_EO.MSN_WW_ID) AND  
( (Msn_EO.TASKED_FR_UNIT_ID = '24MEU') OR  
(Msn_EO.TASKED_FR_UNIT_ID = '11MEU') OR  
(Msn_EO.TASKED_FR_UNIT_ID = '24 MEU CE') OR  
(Msn_EO.TASKED_FR_UNIT_ID = '11 MEU CE') OR  
(Msn_EO.TASKED_FR_UNIT_ID = 'VMM163') OR  
(Msn_EO.TASKED_FR_UNIT_ID = 'VMM365')) ORDER BY  
AbpReq_EO.ABP_REQ_NLT_DTTM
```

This view object has a ‘where’ clause so that it will only pull data for the units that fall under the 24th and 11th MEUs. This allows the user to customize the data that they will be viewing.

c. *Air_MissionVO*

```
SELECT Msn_EO.TASKED_FR_UNIT_ID, Msn_EO.MSN_WW_ID,
Msn_EO.ABP_WW_ID, AsrMsnPrg_EO.ASR_REQ_ID,
AsrMsnPrg_EO.ABP_WW_ID AS ABP_WW_ID1,
AsrMsnPrg_EO.ABP_REQ_ID, AsrMsnPrg_EO.MSN_WW_ID AS
MSN_WW_ID1, AsrMsnPrg_EO.ASR_MS_N_PRG_ID,
AsrMsnPrg_EO.AMO_ID, AbpReq_EO.ABP_REQ_NLT_DTTM,
AbpReq_EO.ABP_WW_ID AS ABP_WW_ID2, AbpReq_EO.ABP_REQ_ID AS
ABP_REQ_ID1, AbpReq_EO.MSN_CAT_CD FROM
COMBINED_SCHEMA.ATOPLN_MSN
Msn_EO, COMBINED_SCHEMA.ATOPLN_ASR_MS_N_PRG
AsrMsnPrg_EO, COMBINED_SCHEMA.ATOPLN_ABP_REQ AbpReq_EO WHERE
(Msn_EO.MSN_WW_ID = AsrMsnPrg_EO.MSN_WW_ID) AND
(Msn_EO.MSN_WW_ID = AbpReq_EO.MSN_WW_ID) AND
((Msn_EO.TASKED_FR_UNIT_ID = '24MEU') OR
(Msn_EO.TASKED_FR_UNIT_ID = '11MEU') OR
(Msn_EO.TASKED_FR_UNIT_ID = '24 MEU CE') OR
(Msn_EO.TASKED_FR_UNIT_ID = '11 MEU CE') OR
(Msn_EO.TASKED_FR_UNIT_ID = 'VMM163') OR
(Msn_EO.TASKED_FR_UNIT_ID = 'VMM365'))
```

- Transient Attributes

1. Total Usage

Type: Number

UI Hint/Format Type: None

Groovy Expression: Air_Mission_DetailsVO.("Total_Usage")*100

2. Total Usage Percent

Type: Number

UI Hint/Format Type: Percentage

Groovy Expression: Air_Mission_DetailsVO.("Total_Usage")

This view object has a ‘where’ clause so that it will only pull data for the units that fall under the 24th and 11th MEUs. This allows the user to customize the data that they will be viewing.

d. Air_Mission_DetailsVO

```
SELECT Asr_EO.ASR_UNIT_CALLED_NM,
AsrMsnPrg_EO.ASR_MSN_PRG_ID,
AsrMsnPrg_EO.ABP_WW_ID, AsrMsnPrg_EO.ABP_REQ_ID,
AsrMsnPrg_EO.ASR_REQ_ID, AsrMsnPrg_EO.MSN_WW_ID,
AsrMsnPrg_EO.AMO_ID, AirMsn_EO.AIR_MSN_TAKEOFF_LOC_NM,
AirMsn_EO.MSN_WW_ID AS MSN_WW_ID1,
AirMsn_EO.AIR_MSN_LANDING_LOC_NM,
AirMsnAcft_EO.ACFT_MDS_TYPE_CD, AirMsnAcft_EO.MSN_WW_ID AS
MSN_WW_ID2, AirMsnAcft_EO.AIR_MSN_ACFT_GROUP_ID,
AirMsnAcft_EO.AIR_MSN_ACFT_AIRCRAFT_QY,
Asr_EO.ASR_PYLD_EXTR_CARGO_WT, Asr_EO.ABP_WW_ID AS
ABP_WW_ID1, Asr_EO.ABP_REQ_ID AS ABP_REQ_ID1,
Asr_EO.ASR_REQ_ID AS ASR_REQ_ID1,
Asr_EO.ASR_PYLD_INT_CARGO_WT, TO_NUMBER
(Asr_EO.ASR_PYLD_TROOP_TX)*, Asr_EO.ASR_PYLD_TYPE_CD,
AircraftDetails_EO.AIRCRAFT_MODEL_CODE,
AircraftDetails_EO.CARGO_CAPACITY,
AircraftDetails_EO.PASSENGER_CAPACITY,
AircraftDetails_EO.SCL FROM
COMBINED_SCHEMA.ATOPLN_ASR_MSN_PRG AsrMsnPrg_EO,
COMBINED_SCHEMA.ATOPLN_AIR_MSN AirMsn_EO,
COMBINED_SCHEMA.ATOPLN_AIR_MSN_ACFT
AirMsnAcft_EO, COMBINED_SCHEMA.ATOPLN_ASR
Asr_EO, COMBINED_SCHEMA.AIRCRAFT_DETAILS AircraftDetails_EO
WHERE (AsrMsnPrg_EO.MSN_WW_ID = AirMsn_EO.MSN_WW_ID) AND
(AirMsn_EO.MSN_WW_ID = AirMsnAcft_EO.MSN_WW_ID) AND
(AsrMsnPrg_EO.ASR_REQ_ID = Asr_EO.ASR_REQ_ID) AND
(AirMsnAcft_EO.Acft_MDS_TYPE_CD =
AircraftDetails_EO.Aircraft_Model_code) AND
(ASR_EO.ASR_Pyld_Type_CD = AircraftDetails_EO.SCL)
```

- Transient Attributes

1. ASR_INT_PLYD

Type: Number

UI Hint/Format Type: Percentage

Groovy Expression:

```
if(AsrPyldIntCargoWt>0){(AsrPyldIntCargoWt/CargoCapacity)}
else if(AsrPyldIntCargoWt == 0){0}
```

2. ASR_EXT_PLYD

Type: Number

UI Hint/Format Type: Percentage

Groovy Expression:

```
if(AsrPyldExtrCargoWt > 0)
{(AsrPyldExtrCargoWt/CargoCapacity)}else
if(AsrPyldExtrCargoWt == 0){0}
```

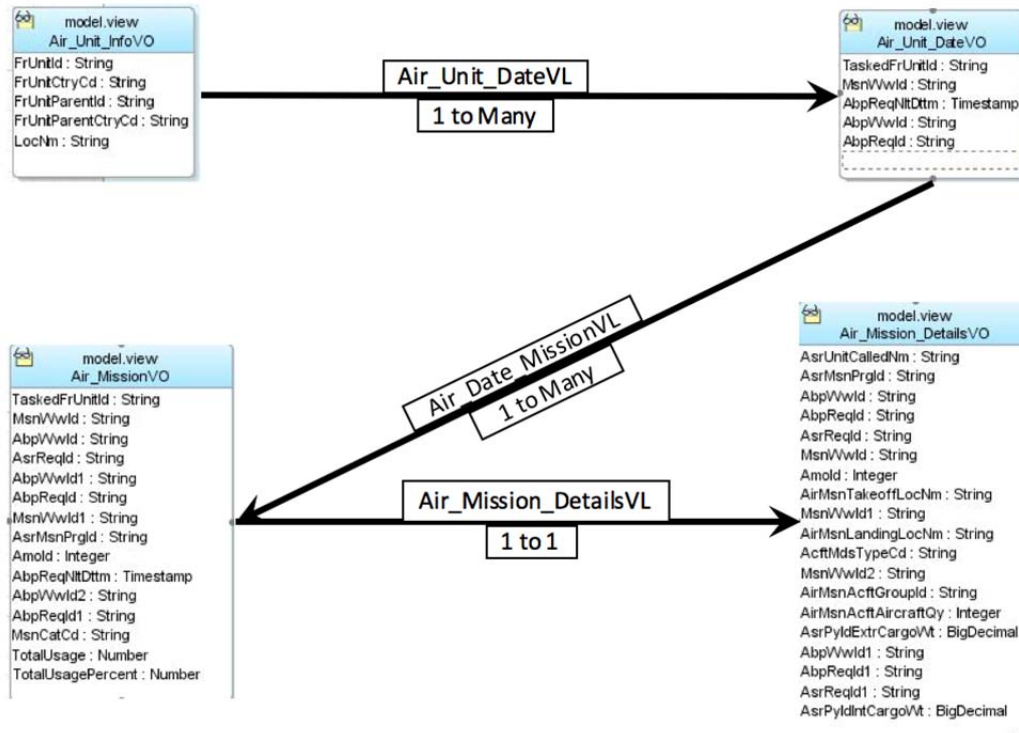
3. ASR_PAX

```
Type: Number
UI Hint/Format Type: Percentage
Groovy Expression:
if(AsrPyldTroopTx > 0){(AsrPyldTroopTx/PassengerCapacity)}
else if(AsrPyldTroopTx == 0){0}
```

4. Total Usage

```
Type: Number
UI Hint/Format Type: Percentage
Groovy Expression: Asr_Int_Pyld + Asr_Ext_Pyld + Asr_Pax
```

As noted by the '*' in the 'Air_Mission_DetailsVO,' the attribute 'ASR_PYLD_Troop_TX' from the ASR table in the ATOPLN schema has a 'To_Number' command before it. This is because in the database, this field is a text field. In order to do the necessary calculations, it must be converted into a number field. This will not cause an issue with the ETL process because this manipulation does not occur at the model layer. It is happening in the control layer via this view object in Figure 25.



This shows the view objects and view links used to build the air page.

Figure 25. Air Page View Object and View Link Relationship

2. View Links

a. *Air_Unit_InfoVO to Air_Unit_DateVO*

Source: Air_Unit_InfoVO.FrUnitID

Destination: Air_Unit_DateVO.TaskedFrUnitId

Cardinality: 1 to many

b. *Air_Unit_DateVO to Air_MissionVO*

Source: Air_Unit_DateVO.TaskedFrUnitId

Destination: Air_MissionVO.TaskedFrUnitId

Source: Air_Unit_DateVO.ABPREQNLTDTTM

Destination: Air_MissionVO.ABPREQNLTDTTM

Cardinality: 1 to many

c. *Air_Mission_VO to Air_Mission_DetailsVO*

Source: Air_MissionVO.MSNWWID

Destination: Air_Mission_DetailsVO.MSNWWID
Cardinality: 1 to 1

3. Application Module

The air application module is to be built as shown in the Figure 26.

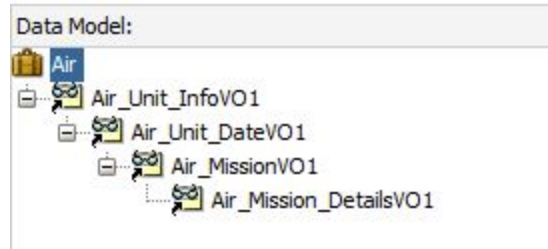


Figure 26. Air Application Module

B. GROUND PAGE

1. View Objects

a. *Ground_Unit_InfoVO*

```
SELECT TcptUnits_EO.ID, TcptUnits_EO.SHORT_NAME,  
TcptUnits_EO.PARENT_ID, TcptUnits_EO.LOCATION_ID FROM  
COMBINED_SCHEMA.TCPT_UNITS TcptUnits_EO WHERE  
(TcptUnits_EO.ID = 3317) OR (TcptUnits_EO.ID = 1280)  
OR (TcptUnits_EO.ID = 532) OR (TcptUnits_EO.ID = 3)  
OR (TcptUnits_EO.ID = 554) OR (TcptUnits_EO.ID = 63)
```

This view object has a where clause so that it will only pull data for the units that fall under the 24th and 11th MEUs. This allows the user to customize the data that they will be viewing.

b. *Ground_Unit_DateVO*

```
SELECT TcptMission_EO.ID,  
TcptMission_EO.ORGANIZATION_ID,  
TcptMission_EO.ARRIVAL_TIME FROM  
COMBINED_SCHEMA.TCPT_MISSION TcptMission_EO ORDER BY  
TcptMission_EO.ARRIVAL_TIME
```

c. Ground_MissionVO

```
SELECT TcptMission_EO.ORGANIZATION_ID,  
TcptMission_EO.ID, TcptMission_EO.ARRIVAL_TIME,  
TcptMission_EO.DESTINATION,  
TcptMission_EO.MISSION_DISTANCE,  
TcptUnits_EO.ID AS ID1, TcptUnits_EO.NAME FROM  
COMBINED_SCHEMA.TCPT_MISSION TcptMission_EO,  
COMBINED_SCHEMA.TCPT_UNITS TcptUnits_EO WHERE  
TcptMission_EO.ORGANIZATION_ID = TcptUnits_EO.ID
```

- Transient Attributes

1. Vehicle Count

Type: Number
UI Hint/Format Type: Number
Groovy Expression:
Ground_Mission_VehiclesVO.count("EquipmentId")

2. Total Cargo

Type: Number
UI Hint/Format Type: None
Groovy Expression:
Ground_Mission_VehiclesVO.sum("CargoWeight")

3. Total Pax

Type: Number
UI Hint/Format Type: Number
Groovy Expression:
Ground_Mission_VehiclesVO.sum("Passengers")

4. Mission Space Usage

Type: Number
UI Hint/Format Type: Percentage
Groovy Expression:
if(VehicleCount > 0){Ground_Mission_VehiclesVO.avg
("SpaceCapacity")}else{0}

5. Mission Pax Usage

Type: Number
UI Hint/Format Type: Percentage

Groovy Expression:
 if(VehicleCount>0){Ground_Mission_VehiclesVO.avg("PassengerCapacity")}else{0}

6. Mission Weight Usage

Type: Number
 UI Hint/Format Type: Percentage
 Groovy Expression:
 if(VehicleCount >0){Ground_Mission_VehiclesVO.avg("WeightCapacity")}else{0}

7. Total Usage

Type: Number
 UI Hint/Format Type: None
 Groovy Expression: (MissionSpaceUsage + MissionPaxUsage + MissionWeightUsage)*100

8. Total Usage Percent

Type: Number
 UI Hint/Format Type: Percentage
 Groovy Expression: (MissionSpaceUsage + MissionPaxUsage + MissionWeightUsage)

d. Ground_Mission_VehiclesVO

```
SELECT TcptMasterLog_EO.MASTER_ID,
TcptMasterLog_EO.MISSION_ID,
TcptMasterLog_EO.EQUIPMENT_ID,
TcptMasterLog_EO.FUEL_USED,
TcptMasterLog_EO.LOAD_ID,
TcptMasterLog_EO.MILES_TRAVELED,
TcptMasterLog_EO.PASSENGERS,
TcptMasterLog_EO.CARGO_WEIGHT,
TcptLoad_EO.LOAD_ID AS LOAD_ID1, TcptLoad_EO.MISSION_ID
AS MISSION_ID1,
TcptLoadEquipment_EO.EQUIPMENT_ID AS EQUIPMENT_ID1,
TcptLoadEquipment_EO.LOAD_ID AS LOAD_ID2,
TcptLoadTmrLines_EO.LOAD_ID AS LOAD_ID3,
TcptLoadTmrLines_EO.TMR_LINE_ITEM_ID,
TcptLoadTmrLines_EO.QTY, TcptTmrLineitems_EO.ID,
TcptTmrLineitems_EO.CARGO_ID, TcptCargoPaxType_EO.ID AS
ID1, TcptCargoPaxType_EO.DESCRPTION,
TcptEquipmentCapabilities_EO.EQUIPMENT_ID AS
EQUIPMENT_ID2,
```

```

TcptEquipmentCapabilities_EO.FOURSIXTHREELON,
TcptEquipmentCapabilities_EO.FUELON,
TcptEquipmentCapabilities_EO.ISOON,
TcptEquipmentCapabilities_EO.PALCON_ON,
TcptEquipmentCapabilities_EO.PAXON,
TcptEquipmentCapabilities_EO.QUADCONON,
TcptEquipmentCapabilities_EO.SIXCONON,
TcptEquipmentCapabilities_EO.STDPALLETON,
TcptEquipmentCapabilities_EO.TEU_ON,
TcptEquipmentCapabilities_EO.TOTALSTON,
TcptEquipmentCapabilities_EO.WATERBULKON,
TcptEquipmentCapabilities_EO.WATERUNITON,
TcptEquipment_EO.EQUIPMENT_ID AS EQUIPMENT_ID3,
TcptEquipment_EO.TAMCN_ID, TcptTamcns_EO.ID AS ID2,
TcptTamcns_EO.NOMENCLATURE FROM
COMBINED_SCHEMA.TCPT_MASTER_LOG TcptMasterLog_EO,
COMBINED_SCHEMA.TCPT_LOAD TcptLoad_EO,
COMBINED_SCHEMA.TCPT_LOAD_EQUIPMENT
TcptLoadEquipment_EO,
COMBINED_SCHEMA.TCPT_LOAD_TMR_LINES
TcptLoadTmrLines_EO, COMBINED_SCHEMA.TCPT_TMR_LINEITEMS
TcptTmrLineitems_EO,
COMBINED_SCHEMA.TCPT_CARGO_PAX_TYPE
TcptCargoPaxType_EO,
COMBINED_SCHEMA.TCPT_EQUIPMENT_CAPABILITIES
TcptEquipmentCapabilities_EO,
COMBINED_SCHEMA.TCPT_EQUIPMENT TcptEquipment_EO,
COMBINED_SCHEMA.TCPT_TAMCNS TcptTamcns_EO WHERE
((((TcptMasterLog_EO.Load_ID = TcptLoad_EO.Load_ID)
AND (TcptLoad_EO.LOAD_ID =
TcptLoadEquipment_EO.LOAD_ID))
AND (TcptMasterLog_EO.Equipment_ID =
TcptLoadEquipment_EO.Equipment_ID)
AND (TcptLoadEquipment_EO.LOAD_ID =
TcptLoadTmrLines_EO.LOAD_ID))
AND (TcptLoadTmrLines_EO.TMR_LINE_ITEM_ID =
TcptTmrLineitems_EO.ID))
AND (TcptTmrLineitems_EO.CARGOID =
TcptCargoPaxType_EO.ID))
AND (TcptLoadEquipment_EO.Equipment_ID =
TcptEquipmentCapabilities_EO.Equipment_ID)
AND (TcptLoadEquipment_EO.Equipment_ID =
TcptEquipment_EO.Equipment_ID)
AND (TcptEquipment_EO.TAMCN_ID = TcptTamcns_EO.ID)

```

- Transient Attributes

1. Weight Capacity

Type: Number

UI Hint/Format Type: Percentage

Groovy Expression: `if(CargoWeight > 0 && Totalston > 0){((CargoWeight/2000)/Totalston)}else{0}`

2. Passenger Capacity

Type: Number

UI Hint/Format Type: Percentage

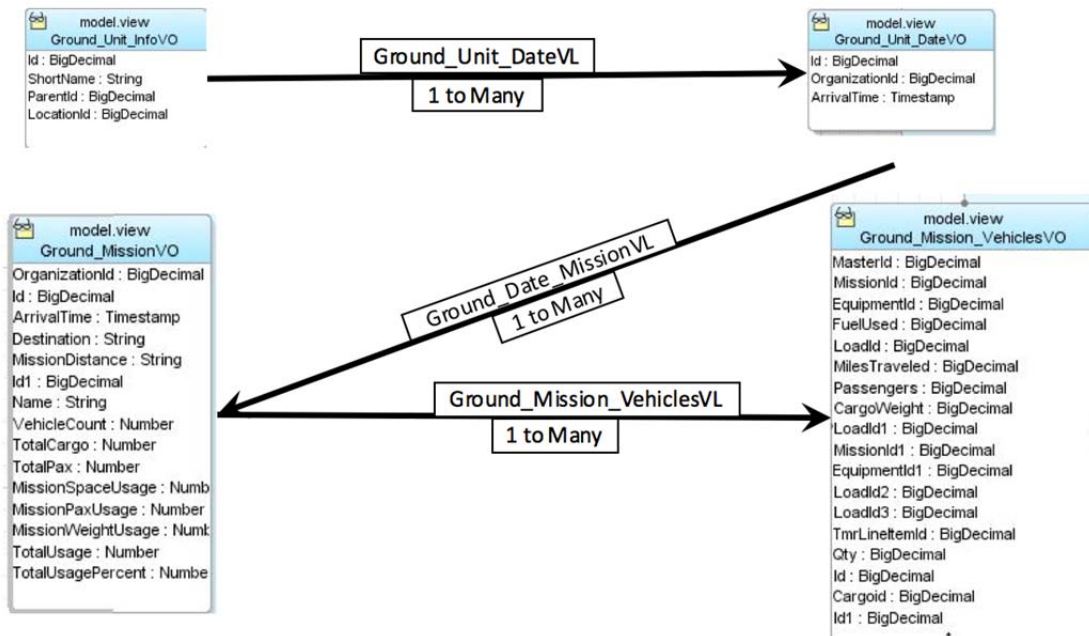
Groovy Expression: `if(Passengers > 0 && Paxon > 0){Passengers/Paxon}else{0}`

3. Space Capacity

Type: Number

UI Hint/Format Type: Percentage

Groovy Expression: `if(Cargoid == 1 && Isooon > 0){Qty/Isooon}else if(Cargoid == 2 && Stdpalleton > 0){Qty/Stdpalleton}else if(Cargoid == 3 && Foursixthreelon > 0){Qty/Foursixthreelon}else if(Cargoid == 4 && Totalston > 0){Qty/Totalston}else if(Cargoid == 5 && Quadconon > 0){Qty/Quadconon}else if(Cargoid == 6 && Fuelon > 0){Qty/Fuelon}else if(Cargoid == 7 && Waterbulkon > 0){Qty/Waterbulkon}else if(Cargoid == 8 && Wateruniton > 0){Qty/Wateruniton}else if(Cargoid == 9 && Paxon > 0){Qty/Paxon}else if(Cargoid == 22 && TeuOn > 0){Qty/Teuon}else if(Cargoid == 16){0}else{0}`



This shows the view objects and view links used to build the ground page.

Figure 27. Ground Page View Object and View Link Relationship

2. View Links

a. *Ground_Unit_InfoVO to Ground_Unit_DateVO*

Source: Ground_Unit_InfoVO.Id
 Destination: Ground_Unit_DateVO.OrganizationId
 Cardinality: 1 to many

b. *Ground_Unit_DateVO to Ground_MissionVO*

Source: Ground_Unit_DateVO.Id
 Destination: Ground_MissionVO.Id
 Cardinality: 1 to many

c. *Ground_MissionVO to Ground_Mission_VehiclesVO*

Source: Ground_MissionVO.Id
 Destination: Ground_Mission_VehiclesVO.MissionId
 Cardinality: 1 to many

3. Application Module

The ground application module should be built as shown in Figure 28.

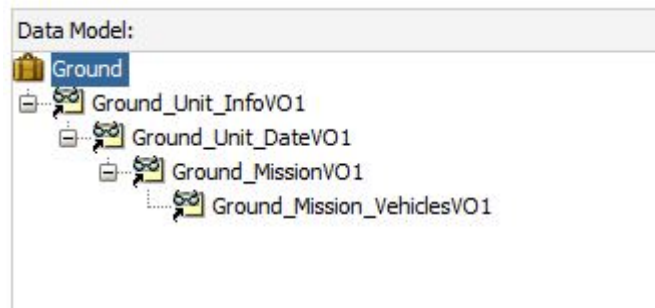


Figure 28. Ground Application Module

C. COMBO PAGE

1. View Objects

a. *Combo_UnitIDVO*

```
SELECT FrUnit_EO.FR_UNIT_ID,FrUnit_EO.FR_UNIT_CTRY_CD,
TcptUnits_EO.ID, TcptUnits_EO.NAME FROM
COMBINED_SCHEMA.FROBDB_FR_UNIT
FrUnit_EO, COMBINED_SCHEMA.TCPT_UNITS TcptUnits_EO WHERE
FrUnit_EO.Fr_Unit_ID = TcptUnits_EO.Name
```

b. *Combo_ParentUnitVO*

```
SELECT FrUnit_EO.FR_UNIT_ID, FrUnit_EO.FR_UNIT_CTRY_CD,
TcptUnits_EO.ID, TcptUnits_EO.NAME FROM
COMBINED_SCHEMA.FROBDB_FR_UNIT FrUnit_EO,
COMBINED_SCHEMA.TCPT_UNITS TcptUnits_EO WHERE
FrUnit_EO.Fr_Unit_ID = TcptUnits_EO.Name
```

- Transient Attributes

1. Total Air Missions

Type: Number

UI Hint/Format Type: None

Groovy Expression:

Combo_ParentUnit_AirMissionVO.count("MsnWwId")

2. Total Ground Missions

Type: Number

UI Hint/Format Type: None

Groovy Expression:

Combo_ParentUnit_GroundMissionsVO.count("MissionId")

3. Total Missions

Type: Number

UI Hint/Format Type: None

Groovy Expression: TotalAirMissions + TotalGroundMissions

4. Average Air Mission Usage

Type: Number

UI Hint/Format Type: Percentage

Groovy Expression:

Combo_ParentUnit_AirMissionVO.avg("MissionUsagePercent")

5. Average Ground Mission Usage

Type: Number

UI Hint/Format Type: Percentage

Groovy Expression:

Combo_ParentUnit_GroundMissionsVO.avg("MissionUsagePercent")

6. Average Mission Usage

Type: Number

UI Hint/Format Type: Percentage

Groovy Expression:

(AvgAirMissionUsage + AvgGroundMissionUsage)/2

7. Red Ground Mission Usage

Type: Number

UI Hint/Format Type: Number

Label: 0-60%

Groovy Expression:

Combo_ParentUnit_GroundMissionsVO.count("MissionUsage != null && MissionUsage < 60 ? MissionUsage : null")

8. Green Ground Mission Usage

Type: Number

UI Hint/Format Type: Number

Label: 81-100%

Groovy Expression:

Combo_ParentUnit_GroundMissionsVO.count("MissionUsage != null && MissionUsage > 80 ? MissionUsage : null")

9. Yellow Ground Mission Usage

Type: Number

UI Hint/Format Type: Number

Label: 61-80%

Groovy Expression:

Combo_ParentUnit_GroundMissionsVO.count("MissionUsage != null && MissionUsage > 60 && MissionUsage < 80 ? MissionUsage : null")

10. Red Air Mission Usage

Type: Number

UI Hint/Format Type: Number

Label: 0-60%

Groovy Expression:

Combo_ParentUnit_AirMissionVO.count("MissionUsage != null && MissionUsage < 60 ? MissionUsage : null")

11. Green Air Mission Usage

Type: Number

UI Hint/Format Type: Number

Label: 81-100%

Groovy Expression:

Combo_ParentUnit_AirMissionVO.count("MissionUsage != null && MissionUsage > 80 ? MissionUsage : null")

12. Yellow Air Mission Usage

Type: Number

UI Hint/Format Type: Number

Label: 61-80%

Groovy Expression:

Combo_ParentUnit_AirMissionVO.count("MissionUsage != null && MissionUsage > 60 && MissionUsage < 80 ? MissionUsage : null")

c. *Combo_ParentUnit_GroundMissionsVO*

SELECT TcptUnits_EO.PARENT_ID, TcptUnits_EO.ID,
TcptUnits_EO.NAME, TcptMission_EO.ID AS ID1,
TcptMission_EO.ARRIVAL_TIME,

```
TcptMission_EO.ORGANIZATION_ID FROM
COMBINED_SCHEMA.TCPT_UNITS TcptUnits_EO,
COMBINED_SCHEMA.TCPT_MISSION TcptMission_EO WHERE
TcptUnits_EO.ID = TcptMission_EO.ORGANIZATION_ID
```

- Transient Attributes

1. Mission Usage

Type: Number
 UI Hint/Format Type: None
 Groovy Expression: Ground_MissionVO.("TotalUsage")

2. Mission Usage Percent

Type: Number
 UI Hint/Format Type: Percentage
 Groovy Expression: Ground_MissionVO.("TotalUsagePercent")

d. Combo_ParentUnit_AirMissionVO

```
SELECT FrUnit_EO.FR_UNIT_PARENT_ID,
FrUnit_EO.FR_UNIT_CTRY_CD, FrUnit_EO.FR_UNIT_ID,
Msn_EO.MSN_WW_ID, Msn_EO.TASKED_FR_UNIT_ID,
AbpReq_EO.ABP_REQ_NLT_DTTM, AbpReq_EO.ABP_WW_ID,
AbpReq_EO.ABP_REQ_ID FROM
COMBINED_SCHEMA.FROBDB_FR_UNIT FrUnit_EO,
COMBINED_SCHEMA.ATOPLN_MSN Msn_EO,
COMBINED_SCHEMA.ATOPLN_ABP_REQ AbpReq_EO WHERE
FrUnit_EO.FR_UNIT_ID = Msn_EO.tasked_fr_unit_id AND
Msn_EO.MSN_WW_ID = AbpReq_EO.MSN_WW_ID
```

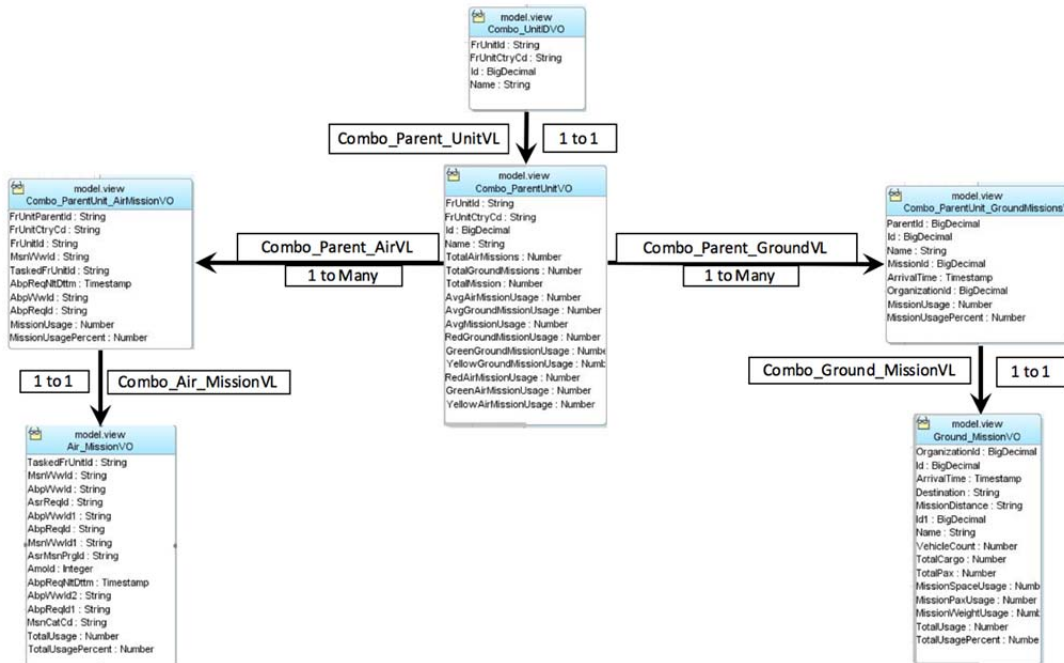
- Transient Attributes

1. Mission Usage

Type: Number
 UI Hint/Format Type: None
 Groovy Expression: Air_Mission_DetailsVO.("Total_Usage")*100

2. Mission Usage Percent

Type: Number
 UI Hint/Format Type: Percentage
 Groovy Expression: Air_Mission_DetailsVO.("Total_Usage")



This shows the view objects and view links used to build the combo page.

Figure 29. Combo Page View Object and View Link Relationship

2. View Links

a. *Combo_UnitIDVO to Combo_ParentUnitVO*

Source: Combo_UnitIDVO.FrUnitId

Destination: Combo_ParentUnitVO.FrUnitId

Cardinality: 1 to many

b. *Combo_ParentUnitVO to Combo_ParentUnit_AirMissionVO*

Source: Combo_ParentUnitVO.FrUnitId

Destination: Combo_ParentUnit_AirMissionVO.FrUnitParentId

Cardinality: 1 to many

c. *Combo_ParentUnit_AirMissionVO to Air_Mission_DetailsVO*

Source: Combo_ParentUnit_AirMissionVO.MsnWWId

Destination: Air_Mission_DetailsVO.MsnWWId

Cardinality: 1 to 1

d. Combo_ParentUnitVO to Combo_ParentUnit_GroundMissionVO

Source: Combo_ParentUnitVO.Id
Destination: Combo_ParentUnit_GroundMissionsVO
Cardinality: 1 to many

e. Combo_ParentUnit_GroundMissionsVO to Ground_MissionVO

Source: Combo_ParentUnit_GroundMissionsVO.MissionId
Destination: Ground_MissionVO.Id
Cardinality: 1 to 1

3. Application Module

The combo application module should be built as shown in Figure 30.

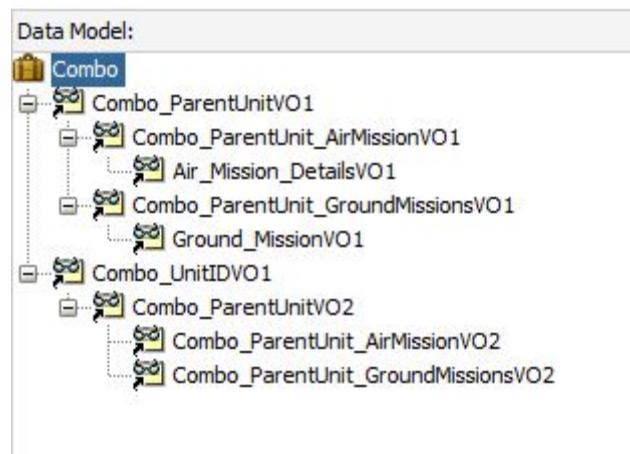


Figure 30. Combo Application Module

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APPENDIX D.

This appendix will provide the reader with the general steps needed in order to recreate the Transportation Capacity tool.

A. GENERAL STEPS

1. Create A New Application in JDeveloper.

1. Select General, Applications, ADF Fusion Web Application.
2. Name the Application, model project and view controller project appropriately.
3. Select all default Java settings.
4. Select Finish.

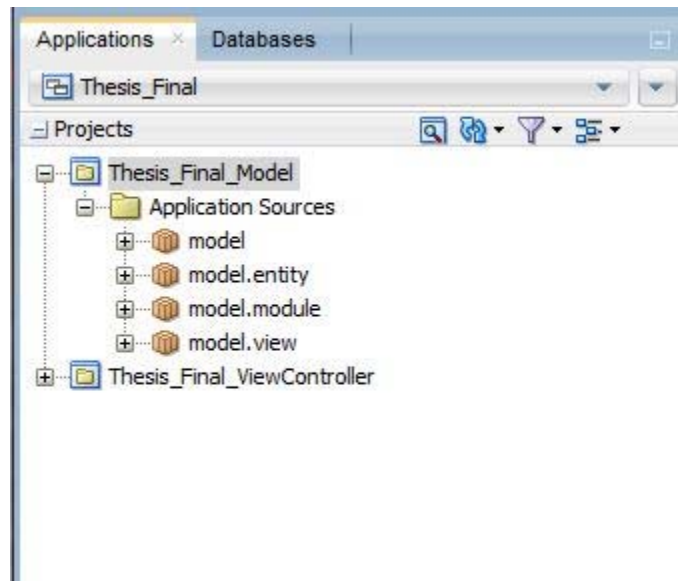


Figure 31. Application Project Window.

2. Create a Connection in JDeveloper to the Database with the Tables Listed in Appendix B.

1. Select Create a Database Connection.
2. Select IDE Connections (in order to use the connection in multiple applications, if desired) or select the Application Name.

3. Name connection.
4. Connection Type: Oracle (JDBC).
5. Username, Password and role will be unique to the database used.
6. Oracle JDBC settings can be left as default.

B. BUILDING THE MODEL PROJECT

1. Create Entity Objects for Tables Listed in Appendix B.

1. In the Model project, create new business components from tables.
2. Select the appropriate schema and tables.
3. Toggle all necessary tables and rename if required.
4. Rename Entity objects in accordance with the organizations naming conventions.
5. For this application, there were no entity-based View objects or Query-based view objects created.
6. Add selected tables to the application module.
7. Once finished, all Entity objects and corresponding associations (based off of primary and foreign keys) will be created under the model.entity tab.

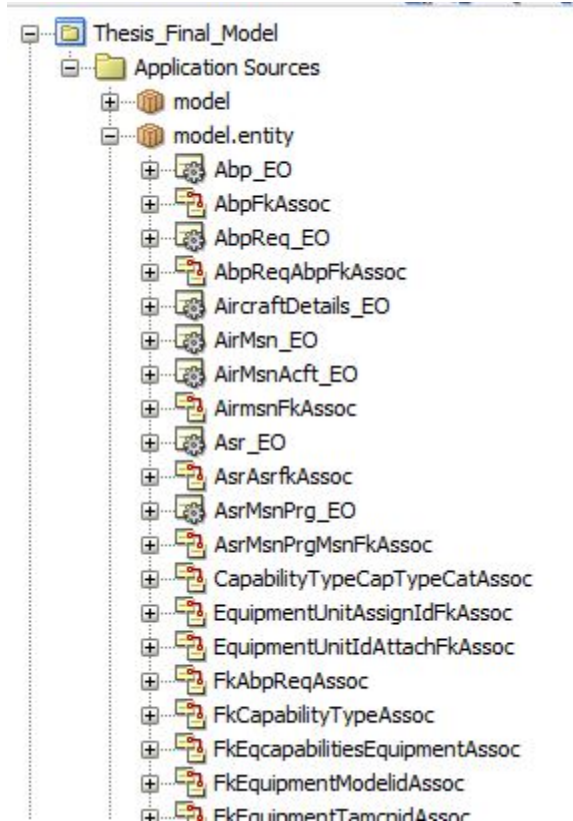


Figure 32. Entity Objects

2. Create View Objects as Identified in Appendix C.

1. In the model project, create new view object.
2. Name view object as identified in Appendix C.
3. Data source will be Entity Object.
4. Under the entity objects tab, select the appropriate entity objects as identified in Appendix C.
5. It is important that the entity objects are added in the same order as shown in the appendix.
6. When there is a relevant association, the 'Join Type' field will become updatable. This field should be changed to 'inner join' for all view objects.
7. Unselect the 'updatable' field. This application will run as a read-only application.

8. Under the attributes tab, select the appropriate attributes as identified in Appendix C.
9. Rename View objects and attributes in accordance with the organizations naming conventions.
10. No attribute settings were changed in this application.
11. Under the 'Query' tab, insert all WHERE and ORDER BY statements as shown in Appendix C.
12. No bind variables were added.
13. Java settings were kept as default.
14. Add View objects to the application module.
15. Once added, all view objects will be visible under the model.view tab.

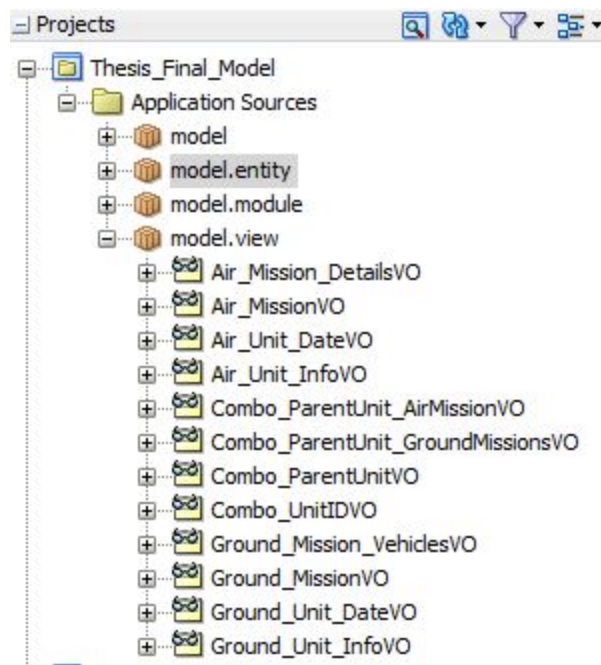


Figure 33. View Objects

3. Create View Links between the View Objects

1. Under the model project, select new view link.
2. Name the view link as shown in Appendix C.
3. Select the source attribute, destination attribute, and cardinality as shown in Appendix C. Select add to bind the view objects.

4. Default settings were selected in the view link properties, edit source query, and edit destination query.
5. Add the view links to the model module.
6. Once finished, all view links will be visible under the model.module tab.

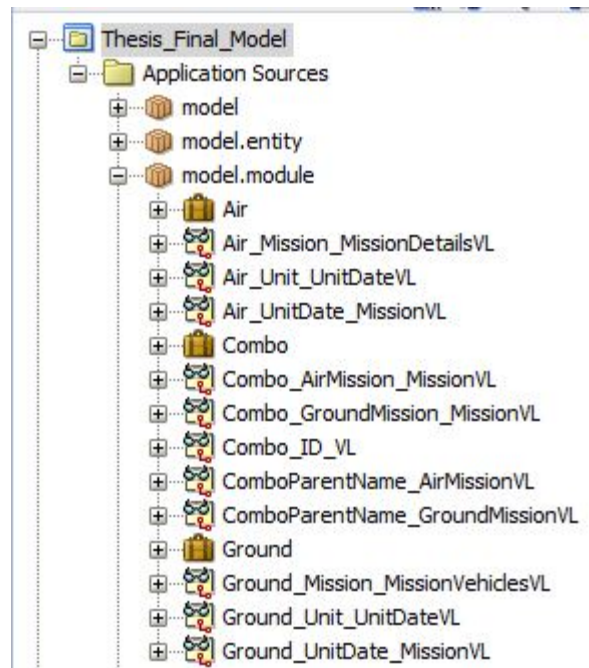


Figure 34. View Links

4. Create All Required Transient Attributes in the View Objects

1. Select a view object that requires a transient attribute.
2. Select the attributes tab.
3. Select the green '+' button and select new attribute.
4. Name the attribute and select the appropriate type. For this application, all transient attributes created were Number.
5. Once added, change default value to 'expression' and insert groovy expressions as identified in Appendix C.
6. Select the UI Hints tab, and change format type as identified in Appendix C.

5. **Create an Application Module for Each of the Different Pages (Air, Ground, and Combo) in Order to Test the View Objects' Functionality.**
 1. Under the model project, select new application module.
 2. Name the module for the appropriate page.
 3. Under the data model tab, toggle the appropriate view objects in the order as annotated in Appendix C.
 4. Java settings remain as default.
 5. Once the application modules are created they will be visible under the model.module tab. Use the application modules to test the data prior to building the pages.

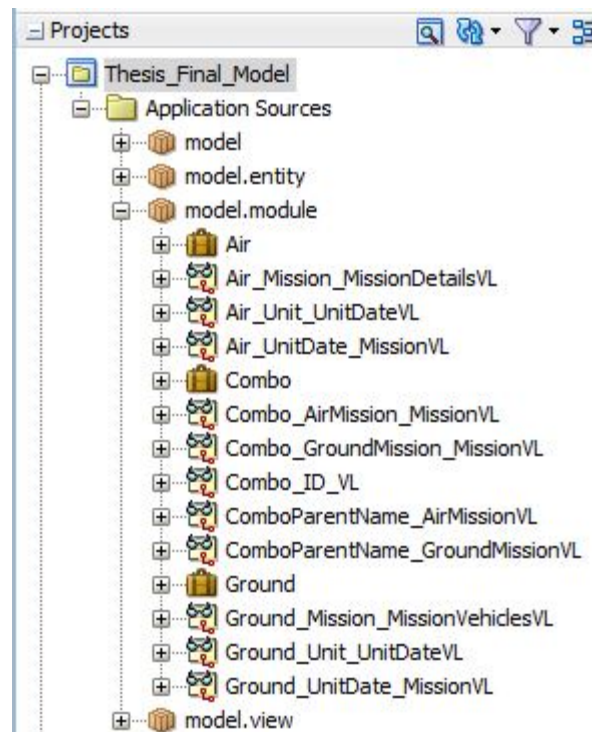


Figure 35. Application Modules

C. BUILDING THE VIEW CONTROLLER PROJECT

1. **Task Flow**
 1. Under the View controller project, select new ADF Task Flow.

2. Unselect 'Create as bounded task flow'.
3. Name task flow as appropriate.
4. Drag the 'View' component from 'Activities' section.
5. Name the 'View' for each page that will be built (There should be 5 views in total)
6. Once all views are created, select the 'Control Flow Case' from the 'Control Flow' tab and select the starting page and end page. Name the flow case as "Go To XX Page".
7. Link all views with control flow cases as shown in Figure 36.

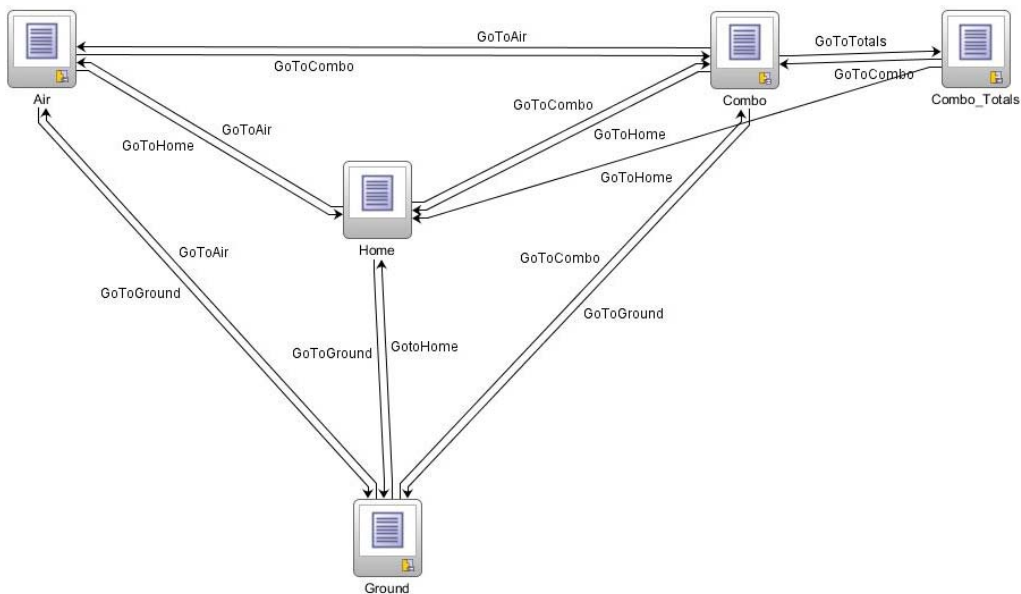


Figure 36. Task Flow

8. Once the .JSF pages are built, they will be linked back to each corresponding view by select the 'Page *' under the General tab. Enter the title of the page as shown in Figure 37.

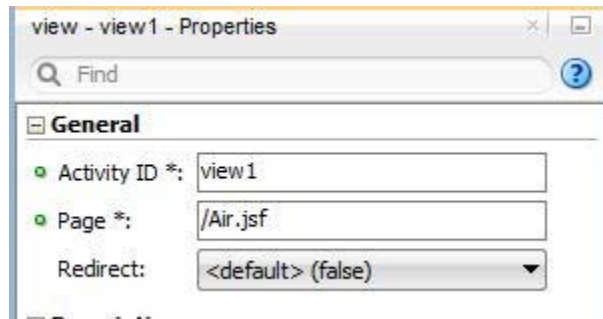


Figure 37. Task Flow View Properties

2. Home Page

1. Under the View Controller Project, select new Page.
2. Name the page.
3. All pages in this application used the format in Figure 38.

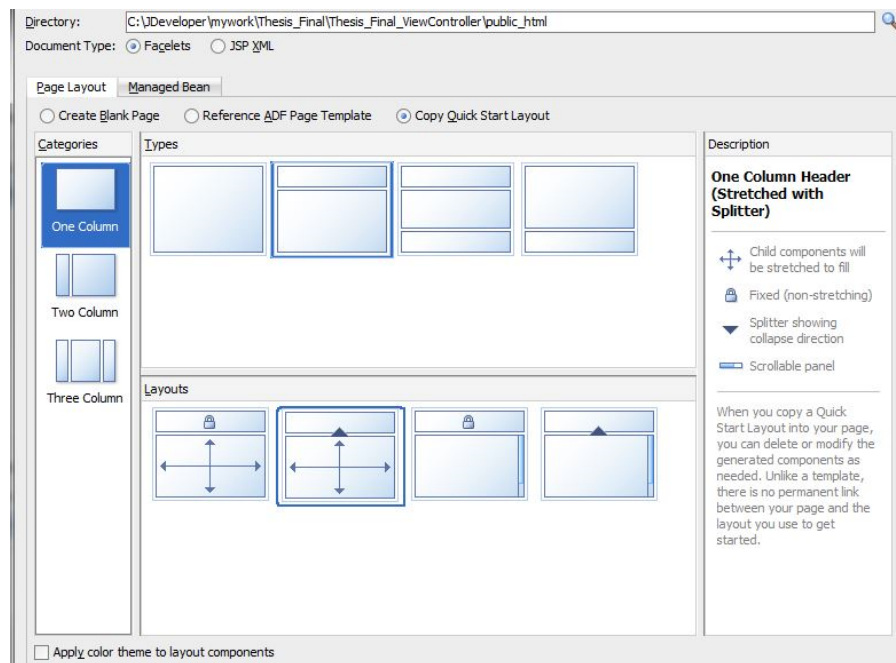


Figure 38. Page Layout

4. Under the first facet in the Vertical panel splitter, drag and drop the 'Image' from the 'General Controls' components.
5. In the source field, locate an image that can be used as the application logo. The logo used for this application was a generic logo saved as a jpeg.

Figure 39 shows the correct location for the image. This image was applied in the same manner on all pages.

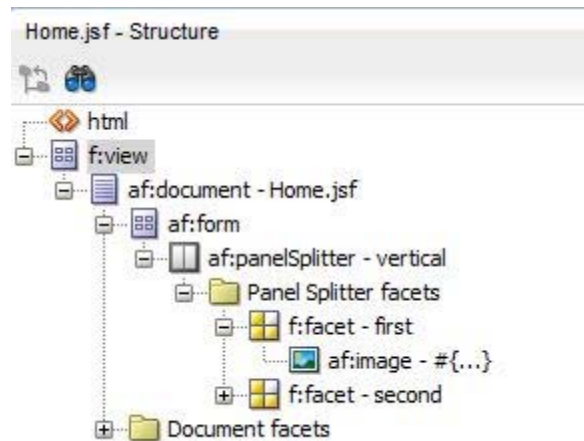


Figure 39. Home Page Structure

6. Under the second facet, drag and drop a 'Panel Group Layout' from 'Layout' tab.
 - Under the 'common' properties:
 - Halign: Center.
 - Valign: Middle.
 - Layout: Horizontal.
7. Add three 'buttons' from the 'General Controls' tab to the 'Panel group layout'.
 - Each button should be named.
 - Under the 'Button Action' tab, select the appropriate action for each button.
- (1) Button Inline Style: height:100px; width:180px; font-size:xx-large; text-align:center; vertical-align:baseline; line-height:80px; font-weight:bold; font-family:" Arial Black "; color:#000052; border-color:#000052; border-width:thick;
8. Figure 40 shows the structure of the second facet of the Home page.

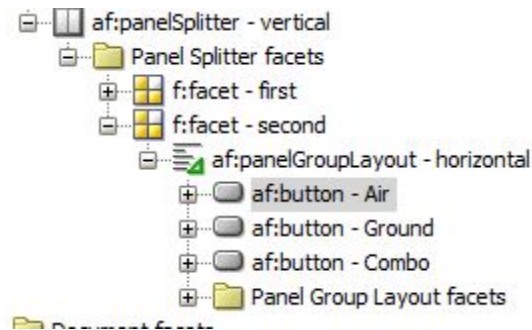


Figure 40. Home Page Structure

3. Air Page

1. Create a new page using the same format as above.
2. Add the logo as above.
3. Under the page's original vertical panel splitter, at a 'Panel Group Layout' and configure the buttons as above.
 - Buttons for the subpages will have the following properties:
 - Button Inline Style: height:50px; width:90px; font-size:large; text-align:center; vertical-align:baseline; line-height:40px; font-weight:bold; font-family:" Arial Black "; color:#000052; border-color:#000052; border-width:thick;
4. Those two sections should be formatted as Figure 41.

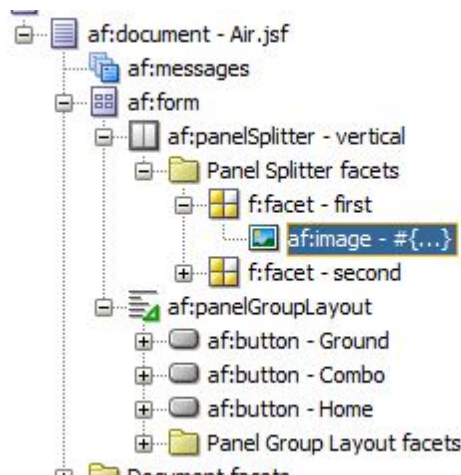


Figure 41. Air Page Structure

5. Under the second facet, add a 'Panel splitter'.

- Orientation: Horizontal.
 - Splitter Position: 300.
6. Under the first facet of the second splitter, add a 'Panel Splitter'.
- Orientation: Vertical.
 - Splitter Position: 300.
7. Under the first facet of the third splitter, add a 'Panel Box' labeled unit.
- Add a 'Panel Form Layout' by dragging the 'Air_Unit_InfoVO1' from the Data controls tab.
 - Select ADF Form.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'FrUnitId' and 'LocNm'.
 - Label the fields Unit and Location.
 - Select ok. The structure should look like Figure 42.

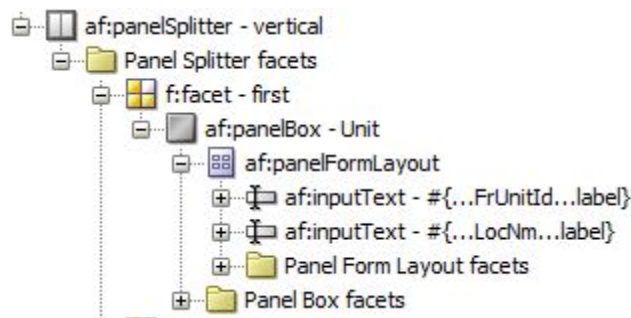


Figure 42. Air Page Structure

8. Under the second facet of the third splitter, add a 'Panel box' labeled date.
- Add a 'Panel Form Layout' by dragging the 'Air_Unit_DateVO1' from the Data controls tab.
 - Select ADF Form.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'AbpReqNLTDTTM'.
 - Label the field: Mission Date.

- The structure should look like the Figure 43.

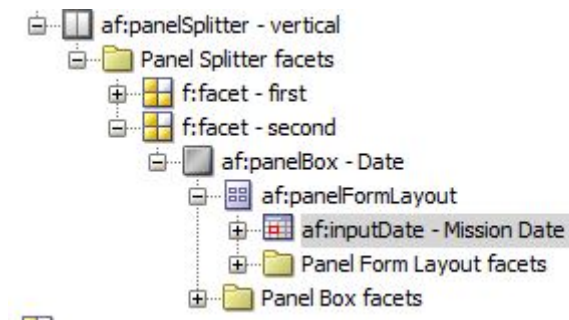


Figure 43. Air Page Structure

- Under the second facet of the second splitter, add a 'Panel Splitter'.
 - Orientation: Vertical.
 - Splitter position: 300.
- Under the first facet of the fourth splitter, add a 'Panel box' labeled Mission.
 - Add a 'table' by dragging the 'Air_MissionVO1' from the Data controls tab.
 - Select ADF Table.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'MsnWWId' 'AbpWWId' 'AsrReqId' 'MsnCatCD' and 'MissionUsage'.
 - Label the fields Mission Id, ABP ID, ASR #, Mission Category and Mission Usage, respectively.
 - Add an additional column to the table and label it Usage meter.
 - Drag and drop a 'Gauge' into this column.
 - The properties should be set as shown in Figure 44.

The image shows a 'Gauge Properties' dialog box with two tabs: 'Common' and 'Gauge Data'.

Common Tab:

- Rendered:** <default> (true) [dropdown]
- Id:** gauge1 [text field]
- GaugeType:** LED [dropdown]
- GaugeSetColumnCount:** [empty text field]
- GaugeSetAlignment:** <default> (GSA_NONE) [dropdown]
- GaugeSetDirection:** <default> (GSD_ACROSS) [dropdown]
- Value:** #{row.bindings.TotalUsage.inputValue} [text field]

Gauge Data Tab:

- Value:** #{row.bindings.TotalUsage.inputValue} [text field]
- TabularData:** [empty text field]
- MinValue:** 0.0 [text field]
- MaxValue:** 100.0 [text field]

Figure 44. Gauge Properties

- Under the 'ThresholdSet' tab, add three thresholds.
 - Threshold 1:
 - Fill color: #ff0000.
 - ThresholdMax Value: 60.0.
 - Threshold 2:
 - Fill color: #ffff00.
 - ThresholdMax Value: 80.0.
 - Threshold 3:
 - Fill color: #00ff00.
 - ThresholdMax Value: 100.0.
- Under the metric label, change number type to 'NT_Percent'.
- The structure should look like Figure 45.

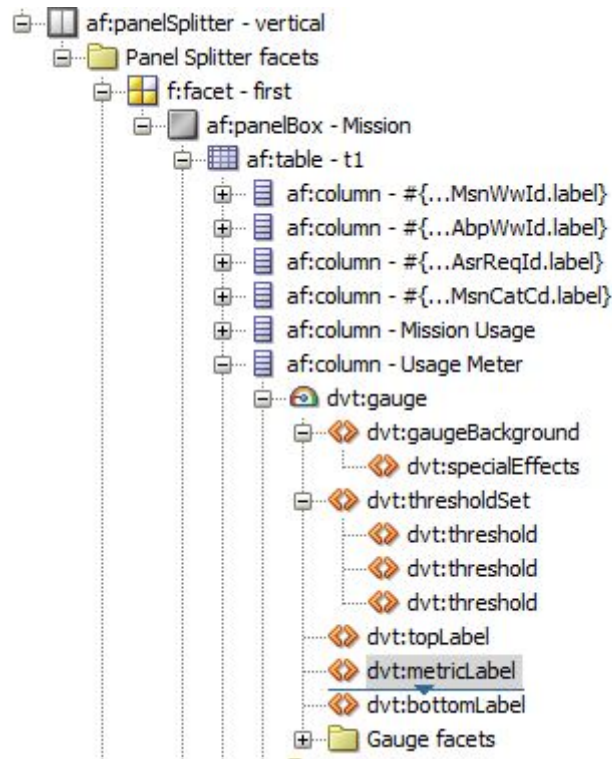


Figure 45. Air Page Structure

11. Under the second facet of the fourth splitter, add a 'Panel Box' labeled Mission Details.
 - Add a 'Panel Format Layout' by dragging the 'Air_Mission_DetailsVO1' from the Data controls tab.
 - Select ADF Form.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'AsrUnitCalledNM' 'AsrReqID' 'AirMsnTakeoffLocNm' 'AirMsnLandingLocNm' 'AcftMdsTypeCd' 'AirMsnAcftAircraftQty' 'AsrPyldIntCargoWt' 'AsrPyldExtrCargoWt' 'AsrPyldTroopTx' 'Asr_Int_Pyld' 'Asr_Ext_Pyld' 'Asr_Pax' 'Total_usage'.
 - Label the fields Unit Supported, AsrReqId, Takeoff Location, Landing Location, A/C Type, A/C Qty, External Cargo Weight (Lbs), Internal Cargo Weight (Lbs), Pax, Internal Usage, External Usage, Pax Usage, Total Usage, respectively.
 - The structure should look like Figure 46.

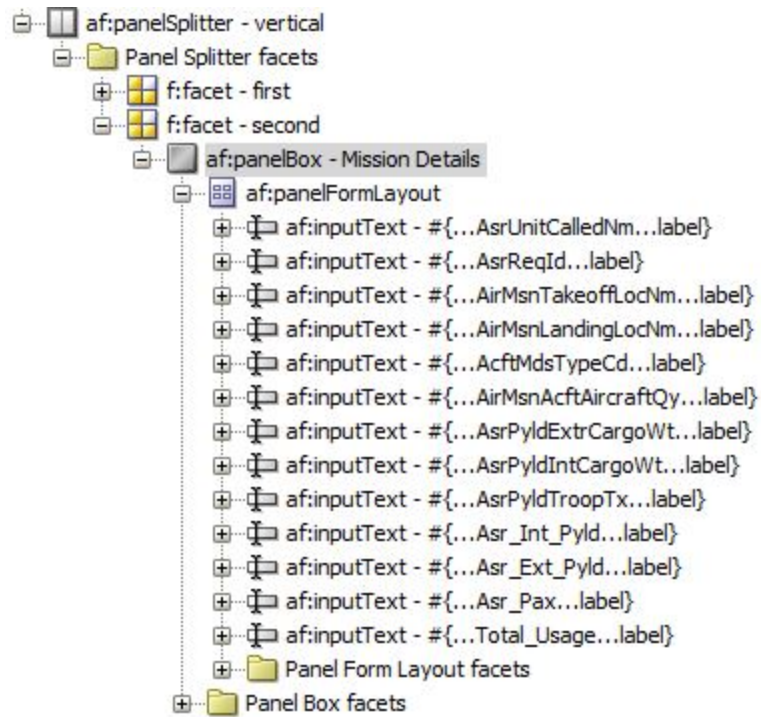


Figure 46. Air Page Structure

12. The final structure of the Air page should look like Figure 47.

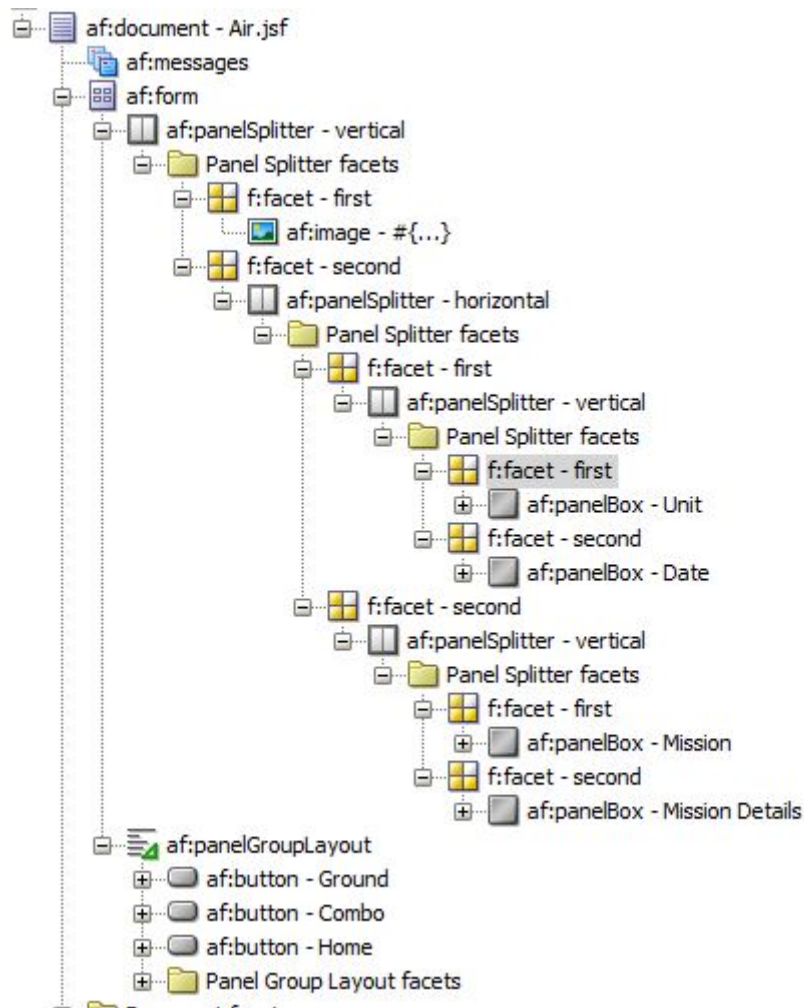


Figure 47. Air Page Structure

D. GROUND PAGE

1. Create a new page using the same format as above.
2. Add the logo as above.
3. Under the page's original vertical panel splitter, at a 'Panel Group Layout' and configure the buttons as above.
 - Buttons for the subpages will have the following properties.
 - Button Inline Style: height:50px; width:90px; font-size:large; text-align:center; vertical-align:baseline; line-height:40px; font-weight:bold; font-family:" Arial Black "; color:#000052; border-color:#000052; border-width:thick;
4. Those two sections should be formatted in Figure 48.

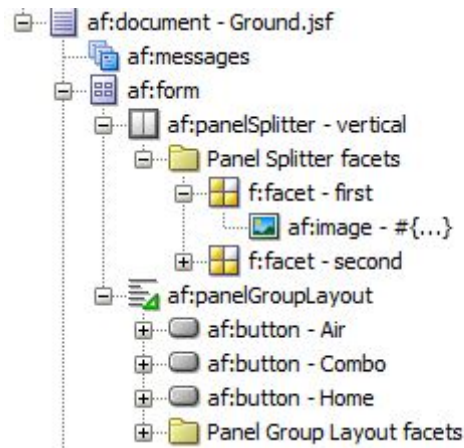


Figure 48. Ground Page Structure

5. Under the second facet, add a 'Panel splitter'.
 - Orientation: Horizontal.
 - Splitter Position: 300.
6. Under the first facet of the second splitter, add a 'Panel Splitter'.
 - Orientation: Vertical.
 - Splitter Position: 300.
7. Under the first facet of the third splitter, add a 'Panel Box' labeled unit.
 - Add a 'Panel Form Layout' by dragging the 'Ground_Unit_InfoVO1' from the Data controls tab.
 - Select ADF Form.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'Id' and 'ShortName'.
 - Label the fields Unit Id and Name.
 - Select ok. The structure should look like Figure 49.

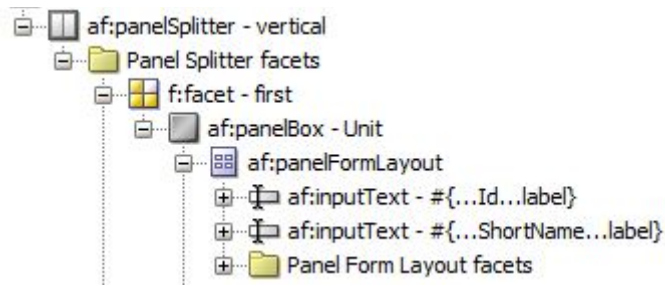


Figure 49. Ground Page Structure

8. Under the second facet of the third splitter, add a 'Panel box' labeled date.
 - Add a 'Panel Form Layout' by dragging the 'Ground_Unit_DateVO1' from the Data controls tab.
 - Select ADF Form.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'ArrivalTime'.
 - Label the field: Mission Date.
 - The structure should look like Figure 50.

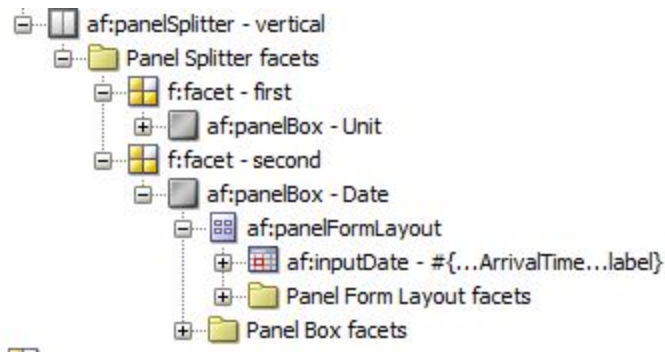


Figure 50. Ground Page Structure

9. Under the second facet of the second splitter, add a 'Panel Splitter'.
 - Orientation: Vertical.
 - Splitter position: 300.
10. Under the first facet of the fourth splitter, add a 'Panel box' labeled Mission.
 - Add a 'table' by dragging the 'Ground_MissionVO1' from the Data controls tab.

- Select ADF Table.
- Select 'Read-only form' and 'row_navigation'.
- Delete all attributes except for 'Id' 'ArrivalTime' 'Destination' 'MissionDistance' 'VehicleCount' 'TotalCargo' 'TotalPax' 'MissionSpaceUsage' 'MissionPaxUsage' 'MissionWeightUsage' 'MissionUsage'.
- Label the fields Mission Id, Mission Date, Destination, Mission Distance, # of Vehicles, Total Cargo, Total Pax, Mission Space Usage, Pax Usage, Weight Usage, and Mission Usage, respectively.
- Add an additional column to the table and label it Usage meter
 - Drag and drop a 'Gauge' into this column
 - The properties should be set as shown in Figure 51.

Common

Rendered: <default> (true)

Id: gauge1

GaugeType: LED

GaugeSetColumnCount:

GaugeSetAlignment: <default> (GSA_NONE)

GaugeSetDirection: <default> (GSD_ACROSS)

Value: #{row.bindings.TotalUsage.inputValue}

Gauge Data

Value: #{row.bindings.TotalUsage.inputValue}

TabularData:

MinValue: 0.0

MaxValue: 100.0

Figure 51. Gauge Properties

- Under the 'ThresholdSet' tab, add three thresholds.
- Threshold 1:
 - Fill color: #ff0000
 - ThresholdMaxValue: 60.0
- Threshold 2:
 - Fill color: #ffff00

- ThresholdMaxValue: 80.0
- Threshold 3:
 - Fill color: #00ff00
 - ThresholdMaxValue: 100.0
- Under the metric label, change number type to 'NT_Percent'.
- The structure should look like Figure 52.

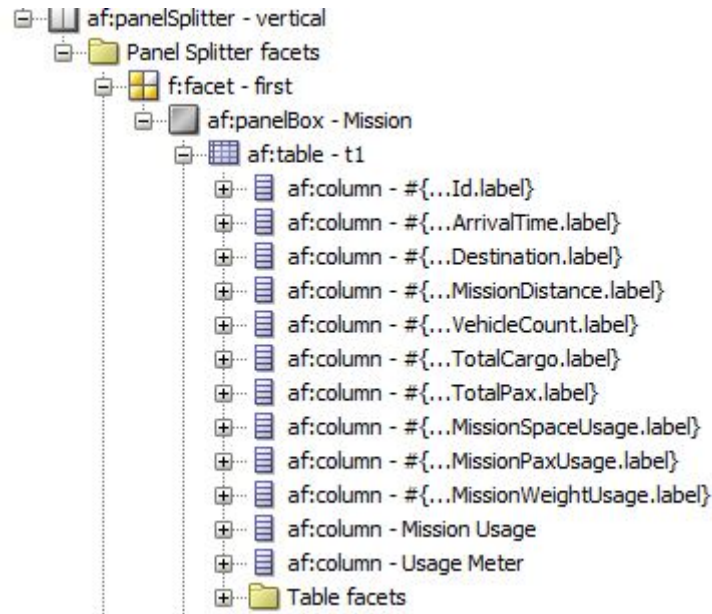


Figure 52. Ground Page Structure

11. Under the second facet of the fourth splitter, add a 'Panel Box' labeled Mission Details.
 - Add a 'Table' by dragging the 'Ground_Mission_VehiclesVO1' from the Data controls tab.
 - Select ADF Table.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'MasterId' 'EquipmentId' 'Nomenclature' 'MilesTraveled' 'FuelUsed' 'Passengers' 'CargoWeight' 'Description' 'Qty' 'WeightCapacity' 'PassengerCapacity' and 'SpaceCapacity'.
 - Label the fields Master ID, Equipment ID, Nomenclature, Miles Traveled, Fuel Used, Pax, Cargo weight, Cargo Type, Qty, Weight Usage, Pax Usage, Space Usage, respectively.
 - The structure should look like Figure 53.

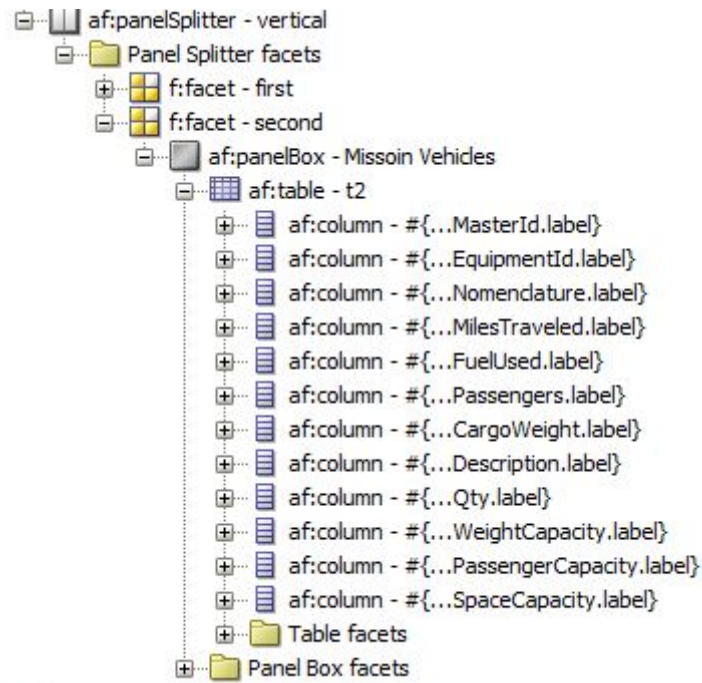


Figure 53. Ground Page Structure

12. The final structure of the Ground page should look like the Figure 54.

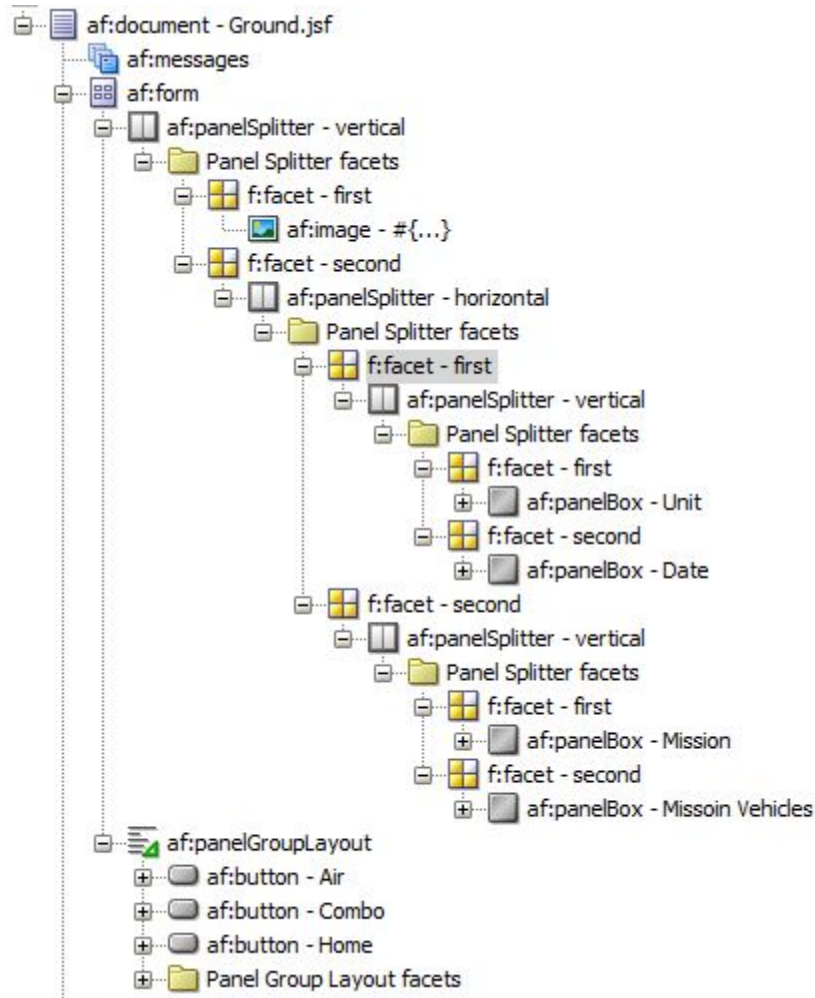


Figure 54. Ground Page Structure

E. COMBO PAGE

1. Create a new page using the same format as above.
2. Add the logo as above.
3. Under the page's original vertical panel splitter, at a 'Panel Group Layout' and configure the buttons as above.
 - Buttons for the subpages will have the following properties.
 - Button Inline Style: height:50px; width:90px; font-size:large; text-align:center; vertical-align:baseline; line-height:40px; font-weight:bold; font-family:" Arial Black "; color:#000052; border-color:#000052; border-width:thick;
4. Those two sections should be formatted as seen in Figure 55.

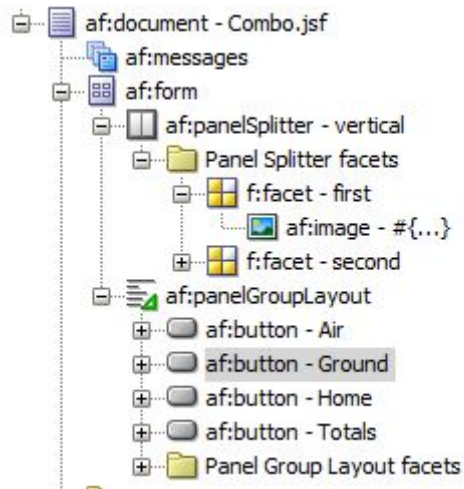


Figure 55. Combo Page Structure

5. Under the second facet, add a 'Panel splitter'.
 - Orientation: Vertical.
 - Splitter Position: 200.
6. Under the first facet of the second splitter, add a 'Panel Box' labeled unit.
 - Add a 'Panel Form Layout' by dragging the 'Combo_ParentUnitVO1' from the Data controls tab.
 - Select ADF Form.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'FrUnitId' 'TotalAirMissions' 'AvgAirMissionUsage' 'TotalGroundMissions' 'AvgGroundMissionUsage' 'TotalMissions' and 'AvgMissionUsage'.
 - Label the fields Unit ID, Air, Avg Air Usage, Ground, Avg Ground Usage, Total Missions, Avg Mission Usage.
 - The structure should look like Figure 56.

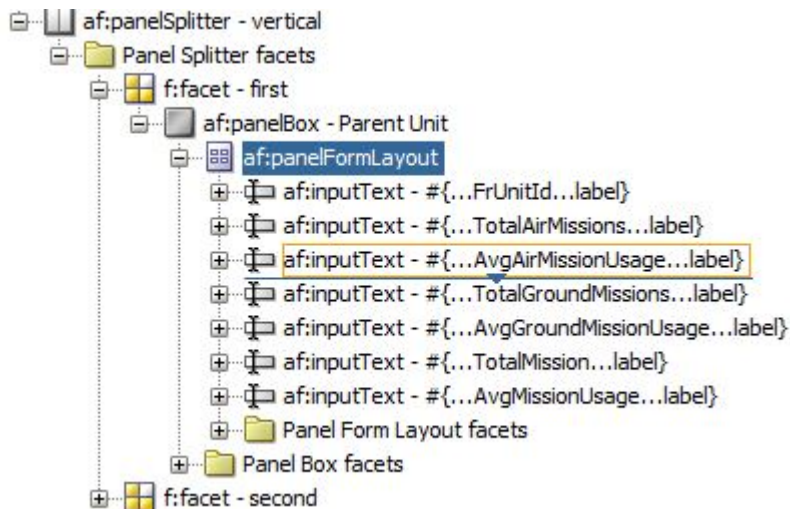
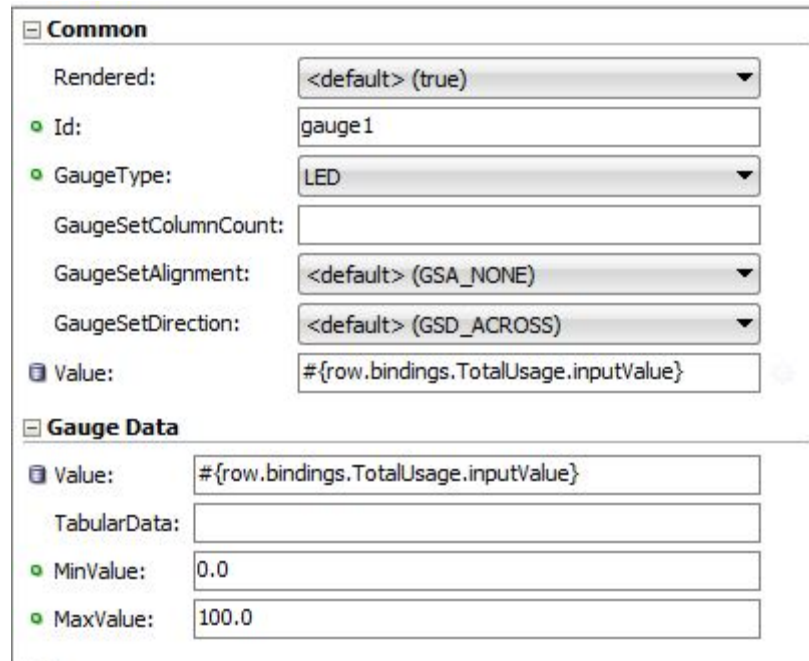


Figure 56. Combo Page Structure

7. Under the second facet of the second splitter, add a 'Panel Splitter'.
 - Orientation: Horizontal.
 - Splitter Position: 500.
8. Under the second facet of the third splitter, add a 'Panel Box' labeled 'Ground missions'.
 - Add a 'Table' by dragging the 'Combo_ParentUnit_GroundMissionVO1' from the Data controls tab.
 - Select ADF table.
 - Select 'Read-only form' and 'row_navigation'.
 - Delete all attributes except for 'Name' 'MissionId' 'ArrivalTime' and 'MissionUsage'.
 - Label the fields Unit Name, Mission ID, Mission Date, and Mission Usage.
 - Add an additional column to the table and label it Usage meter
 - Drag and drop a 'Gauge' into this column
 - The properties should be set as shown in Figure 57.



Common

Rendered: <default> (true) ▼

Id: gauge1

GaugeType: LED ▼

GaugeSetColumnCount:

GaugeSetAlignment: <default> (GSA_NONE) ▼

GaugeSetDirection: <default> (GSD_ACROSS) ▼

Value: #{row.bindings.TotalUsage.inputValue}

Gauge Data

Value: #{row.bindings.TotalUsage.inputValue}

TabularData:

MinValue: 0.0

MaxValue: 100.0

Figure 57. Gauge Properties

- Under the 'ThresholdSet' tab, add three thresholds.
 - Threshold 1:
 - Fill color: #ff0000
 - ThresholdMaxValue: 60.0
 - Threshold 2:
 - Fill color: #ffff00
 - ThresholdMaxValue: 80.0
 - Threshold 3:
 - Fill color: #00ff00
 - ThresholdMaxValue: 100.0
 - Under the metric label, change number type to 'NT_Percent'.
- The structure should look like Figure 58.

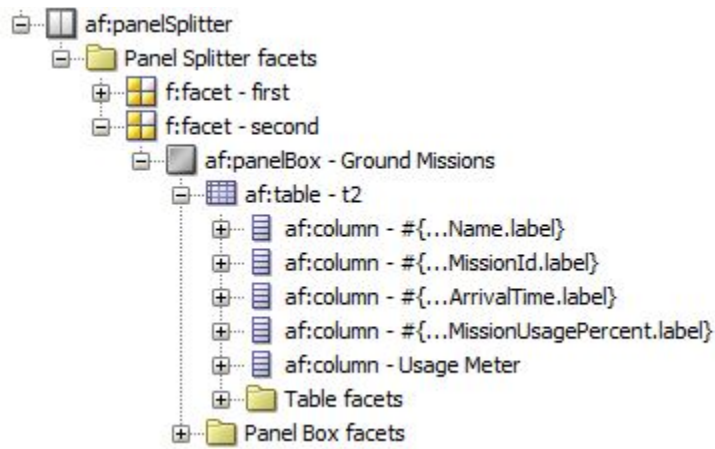


Figure 58. Combo Page Structure

9. The final structure of the Combo page should look like Figure 59.

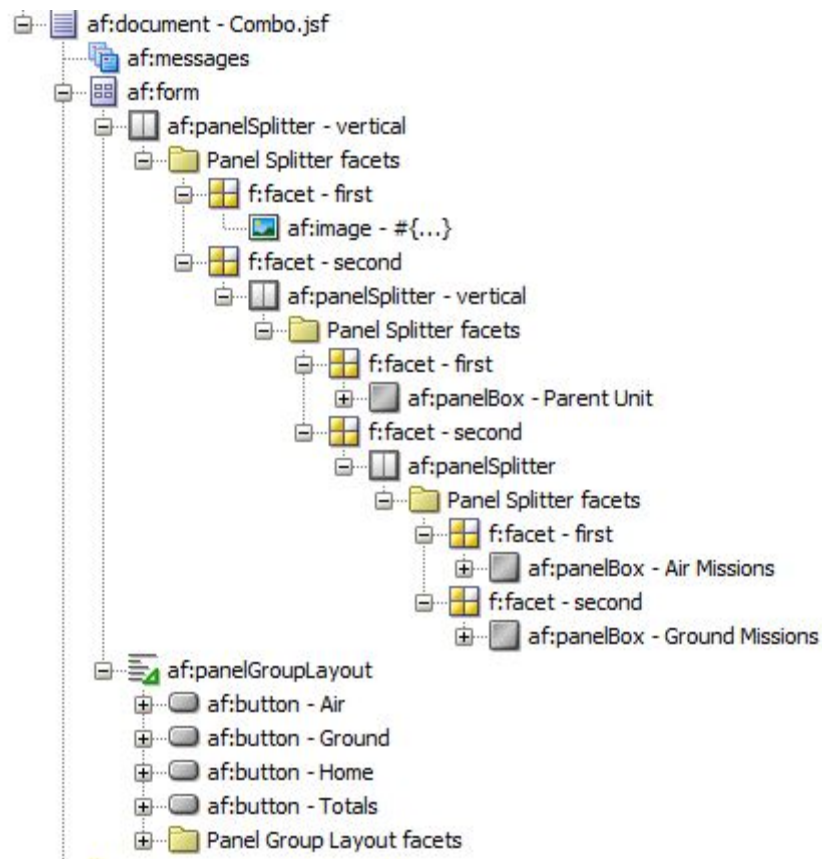


Figure 59. Combo Page Structure

F. COMBO TOTALS

1. Create a new page using the same format as above.
2. Add the logo as above.
3. Under the page's original vertical panel splitter, at a 'Panel Group Layout' and configure the buttons as above.
 - Buttons for the subpages will have the following properties.
 - Button Inline Style: height:50px; width:90px; font-size:large; text-align:center; vertical-align:baseline; line-height:40px; font-weight:bold; font-family:" Arial Black "; color:#000052; border-color:#000052; border-width:thick;
4. Those two sections should be formatted as shown in Figure 60.

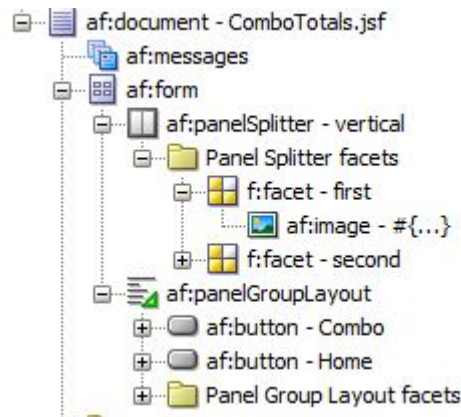


Figure 60. Combo Total Page Structure

5. Under the second facet of the first splitter, add a 'Panel Splitter'.
 - Orientation: Vertical.
 - Splitter Position: 300.
6. Under the first facet of the second splitter, add a 'Panel Splitter'.
 - Orientation: Horizontal.
 - Splitter Position: 700.
7. Under the first fact of the third splitter add a 'Panel Box' labeled 'Unit'.
 - Add a 'Panel Form Layout' by dragging the 'Combo_UnitIDVO1' from the Data controls tab.

- Select ADF Form.
- Select 'Read-only form' and 'row_navigation'.
- Delete all attributes except for 'Name'.
- Label the field Unit Name.
- The structure should look like Figure 61.

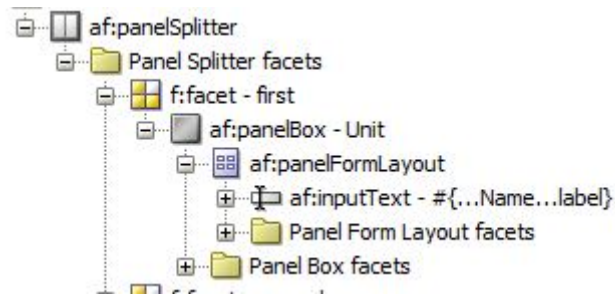


Figure 61. Combo Total Page Structure

- Under the second fact of the third splitter, add 'Panel Box' labeled 'Total Missions'.
 - Add a 'Bar Graph' by dragging 'Combo_ParentUnitVO2' from the data control tab.
 - Under the 'Series Set' pick two colors to represent the two attributes (Air and ground missions).
 - Add two 'Attribute formats' inside the bar graph.
 - Attribute Format 1: Total Ground Missions
`#{bindings.Combo_ParentUnitVO2.hints.TotalGroundMissions.format}`
 - Attribute Format 2: Total Air Missions
`#{bindings.Combo_ParentUnitVO2.hints.TotalAirMissions.format}`
 - 'Y1Title' is Number is missions.
 - The structure should look like Figure 62.

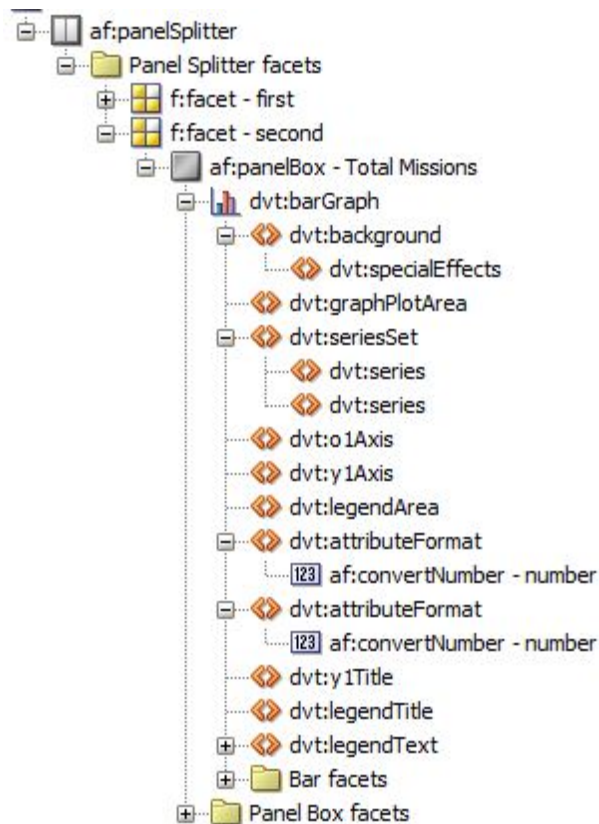


Figure 62. Combo Total Page Structure

9. Under the second facet of the second splitter, add a 'Panel Splitter'.
 - Orientation: Horizontal.
 - Splitter Position: 700.
10. Under the first facet of the fourth splitter, add a 'Panel Box' label 'Ground Mission Usage'.
 - Add a 'Bar Graph' by dragging 'Combo_ParentUnit_GroundMissionVO2' from the data control tab.
 - Under the 'Series Set' pick three colors to represent the three attributes (red, yellow, and green for the different levels of usage).
 - Add three 'Attribute formats' inside the bar graph.
 - Attribute Format 1: Red Ground Mission Usage
`#{bindings.Combo_ParentUnitVO22.hints.RedGroundMissionUsage.format.}`
 - Attribute Format 2: Yellow Ground Mission Usage
`#{bindings.Combo_ParentUnitVO22.hints.YellowGroundMissionUsage.format.}`

- Attribute Format 3: Green Ground Mission Usage
`#{bindings.Combo_ParentUnitVO22.hints.GreenGroundMissionUsage.format}`.
- ‘Y1Title’ is Number is Number of Missions.
- The structure should look like Figure 63.

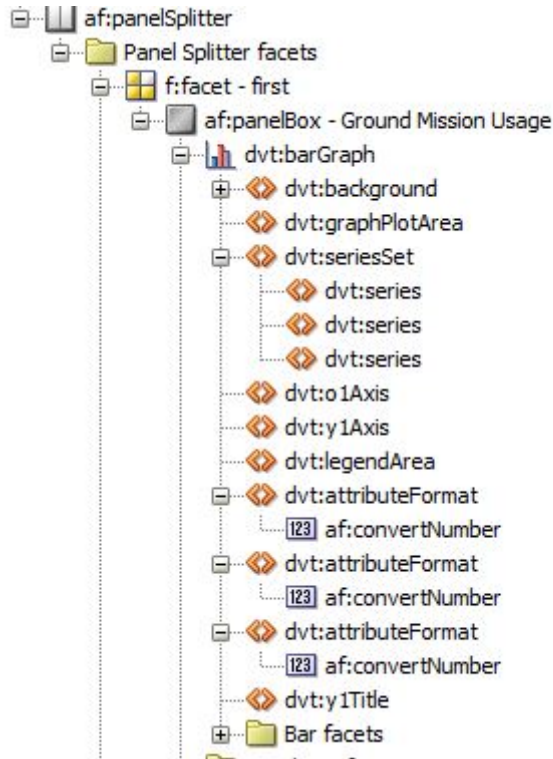


Figure 63. Combo Total Page Structure

11. Under the second facet of the fourth splitter, add a ‘Panel Box’ label ‘Air Mission Usage’.
 - Add a ‘Bar Graph’ by dragging ‘Combo_ParentUnit_AirMissionVO2’ from the data control tab.
 - Under the ‘Series Set’ pick three colors to represent the three attributes (red, yellow, and green for the different levels of usage).
 - Add three ‘Attribute formats’ inside the bar graph.
 - Attribute Format 1: Red Air Mission Usage
`#{bindings.Combo_ParentUnitVO22.hints.RedAirMissionUsage.format}`
 - Attribute Format 2: Yellow Air Mission Usage

```

    #{bindings.Combo_ParentUnitVO22.hints.Yellow
    AirMissionUsage.format}
- Attribute Format 3: Green Air Mission Usage
    #{bindings.Combo_ParentUnitVO22.hints.GreenAi
    rMissionUsage.format}

```

- ‘Y1Title’ is Number is Number of Missions.
- The structure should look like Figure 64.

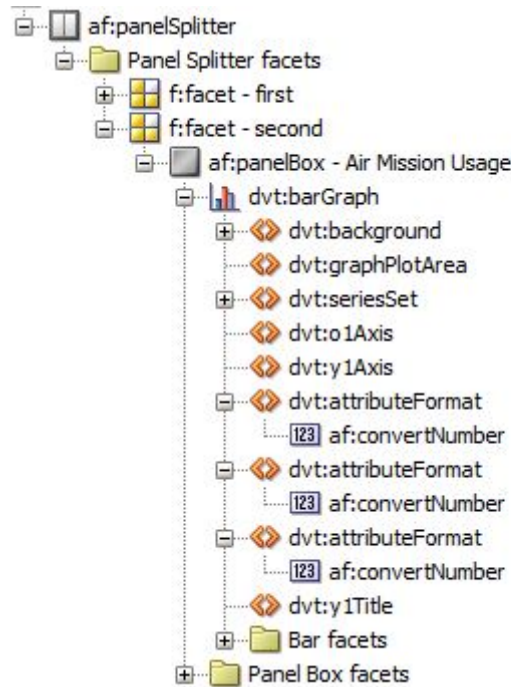


Figure 64. Combo Total Page Structure

12. The final structure of the Combo page should look like Figure 65.

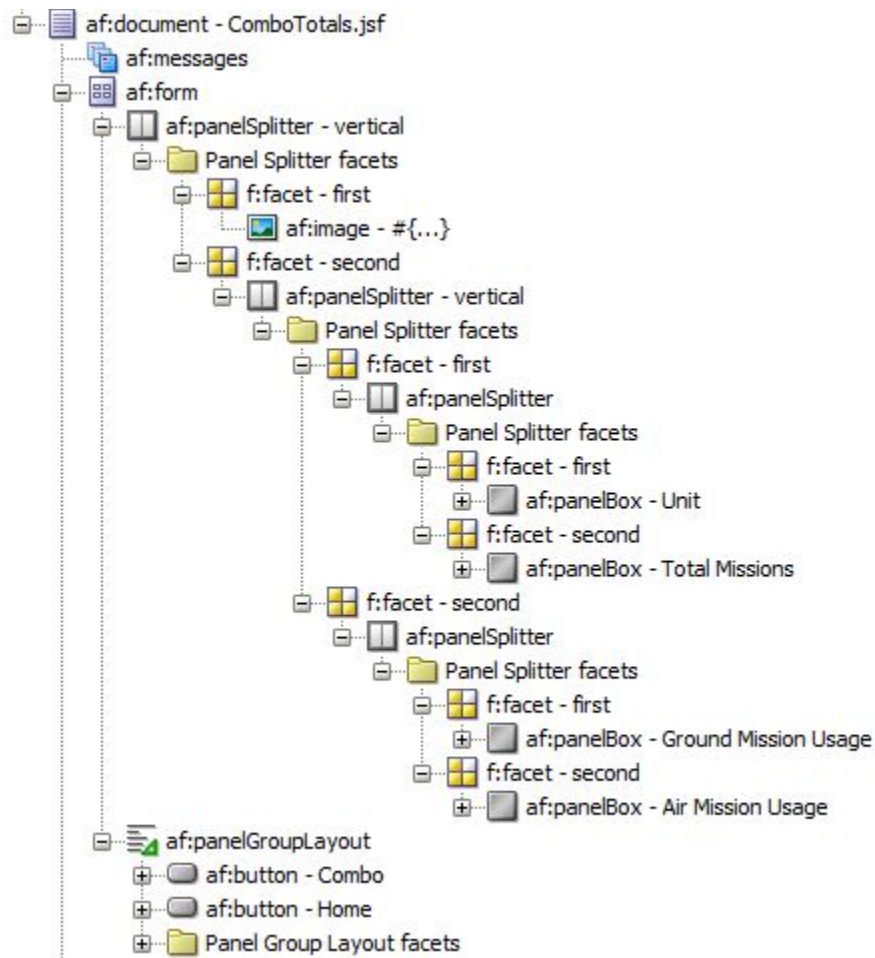


Figure 65. Combo Total Page Structure

G. DEPLOYING TO WEBLOGIC SERVER FOR TESTING

1. Once all pages are built and the Task flow is updated with links, run the application for testing.
2. Select Run.
3. Select 'Run ViewController.jpr'.
4. JDeveloper will connect to the Weblogic Server and run the application in a web browser.
5. This can be used to test the pages' functionality and ensure all buttons are linked properly.

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